Indian Roads Congress
Special Publication 43

GUIDELINES ON LOW-COST TRAFFIC MANAGEMENT TECHNIQUES FOR URBAN AREAS

NEW DELHI 1994

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1. INTRODUCTION

1.1. Impact of Urbanisation

Rapid industrialisation and the consequent urbanisation has brought about an unprecedented revolution in the growth of motor vehicles all over the world; India is no exception. Today, man and his transport vehicles occupy a large share of the urban space. Traffic congestion, Air and Noise Pollution and the resultant ill-effects and frustrations have become the order of the day. Urban transportation systems are wilting under the pressure of ever growing demands on inadequate street network. Serpentine bus queues, pathetically packed suburban trains and the scarcity of taxis during rush hours underscore the pressure on mass transit system. The traffic problem itself is not new; what is new about it is its growing magnitude and complexity.

1.1.1. The Traffic Engineering Committee of the Indian Roads Congress had constituted a Sub-group in May, 1989 to prepare the Guidelines on Low - Cost Traffic Management Techniques for Urban Areas under the Chairmanship of Dr. P.S. Pasricha with Dr. A.C. Sarna, Prof. N. Ranganathan, Shri M.K. Bhalla, Dr. S. Raghava Chari, Shri Dilip Bhattacharya, Dr. P.K. Sikdar and Shri S. Vishwanath, as members. The Sub-group held several meetings and the draft guidelines were prepared and finalised by Dr P.S. Pasricha. The Traffic Engg. Committee (personnel as on 18.10.93 given below) during its meeting held on 18-10-93 approved the draft guidelines subject to certain modifications to be carried out by an editorial committee consisting of Dr. L.R. Kadiyali, S/Shri Maxwell Pereira, T.S. Reddy and A.P. Bahadur:

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1.1.2. Subsequently, the guidelines were approved by Highways Specifications & Standards Committee in its meeting held on 8.11.93. The approval from the Executive Committee was obtained through circulation. The document, thereafter, was considered by the Council in its meeting held on 20.11.93 at Bangalore, wherein Convenor & Member-Secretary of Highways Specifications & Standards Committee were authorised to carry out the editing and minor modifications, if required on the basis of the comments of members before getting the same printed.

2. GROWING IMPORTANCE OF TRAFFIC MANAGEMENT

2.1. Traffic is generally defined as the movement of people, goods or vehicles between spatially separated points, and thus includes pedestrians and all types of vehicles mechanised, motorised or non-motorised . Traffic planning must, therefore, look beyond the expansion of the highway system, and deliberate on the principles of demand and supply so as to use the available infrastructure optimally. Traffic management is the application of sound management principles and practices to optimise the use of the existing road network with a view to improving traffic flow and road safety without impairing environmental quality.

2.2. It has been the experience of many traffic planners that most transportation plans rarely progress beyond the drawing board for lack of financial resources and other related constraints. In many urban areas, socio-economic constraints hutments, ribbon developments etc. are serious impediments to further development, even if the problem of funds is overcome. Provision of new urban transport infrastructure is both long term and capital intensive; resources are simply not available at a scale that matches the escalating demand.

2.3. The only recourse open to the traffic manager, therefore is the option of optimising existing facilities to provide improved accessibility and mobility at a satisfactory level of safety and comfort to most of the road users. This can be achieved after studying and evaluating the problems in the light of sound and tested traffic management techniques which are essentially low cost, easily implementable and flexible. These are short term solutions, primarily intended to reduce the intensity of inconvenience caused by congestion and the multiplicity of the modes of transport conflictingly trying for the same space. They may not offer a permanent solution, yet they lend themselves to some time earning relief upto a point where the administration may launch a long term solution. It is, of course, absolutely imperative to integrate the long term and short term planning. The objectives of the short term solutions should be within the perspective, and be compatible with the goals set out in the long term plans.

2.4. The Traffic Management Techniques that have been tried all over the world have been listed below under seven main categories:

Regulatory Techniques

* oneway streets
* reversible streets
* reversible lanes
* turning movement restrictions
* closing side-streets

Traffic Control Devices

* traffic signs
* road markings
* traffic signals
* computerised signal control system
* traffic cones and drums
* barricades
* speed-breakers
* traffic lighted bollards
* central refuges
* intersection channelisation

Traffic Segregation Techniques

* pedestrian grade-separation
* pedestrian malls
* sidewalks
* central dividers
* footpath and central railings
* creation of storage lanes at turning points
* bus bays
* bicycle lanes
* off-street loading/unloading facilities

Demand Management Techniques

* parking restrictions
* parking supply reduction
* parking pricing
* preferential parking for high - occupancy vehicles
* preferential lanes for high - occupancy vehicles

* road and bridge tolls
* supplementary licensing
* area tolls
* vehicle ownership taxation
* general fare reduction on public transport

Bus Priority Techniques

* priority manoeuvres
* bus lanes
* bus-precincts
* bus priority signal systems
* bus operations management

Self-Enforcing Techniques

* dividers
* railings
* channelisers
* queue channels
* parking notches
* sleeping policeman
* bus bays
* sharing of taxis
* fixed taxi tariff system

Police-Public Interaction Techniques

* education to bring about traffic awareness
* system-condition broadcasts
* traffic booths for and of road users

3. NEED FOR SYSTEMS APPROACH

Though the identification of the problems and the correct diagnosis may automatically suggest the usefulness of a particular management technique, the application of a single technique, in isolation, is rarely sufficient in bringing about a significant improvement in the level of service and transportation mobility of an area. More often than not, the problems shift to the adjacent locality, or an entirely new problem is spawned as a consequence of the very technique used as a solution, if applied in isolation. It is, therefore, essential to seek solutions in a combination of techniques, even in a relatively local situation, for effective management. A solution must be observed as a part of the total scenario and the systems approach used to prepare a Traffic System Management (TSM) Plan for the entire network.

3.1. Selection of Correct Technique(s)

Every city has a traffic complexion of its own, nurtured by its own characteristics. Therefore, it is not wise to import a technique and apply it blindly in a town, merely because it was a success elsewhere. It is necessary to study the areas and sub-areas, and accord correct priorities depending upon the objectives to be achieved. Different sub-areas/ corridors require different treatments depending on the nature of the problems and priority objectives. After examining the funding position and the constraints, in situ, various sub-areas plans can be prepared and mutually integrated to form the programme package. This process presupposes a thorough knowledge of the independent impacts of the TSM actions as well as their interactions. A number of TSM actions can have the desired effect when applied in many similar locations, while there are others that call for related and coordinated actions for each separate application. Certain TSM actions may have a positive impact in one corridor, but may adversely affect another. Therefore, the selection of TSM tools and the study of their combinatory effect is very important, and should never be under emphasised.

3.2. Community Involvement

It must be also understood that public participation and cooperation are the most essential pre-requisites for the success of TSM programmes,

especially in a developing country like India where diversity of social customs and prejudices abounds. Traffic management and community involvement are two sides of the same coin and are not mutually exclusive.

Any attempt to bypass the community would prove counter productive in the long run and no major scheme will be able to survive for a long time. The traffic management plan should be administratively sound, politically tolerated and socially acceptable. All efforts should be made to involve the people. They should be given prior details of the proposal(s) through print/audio/video media and their comments/opinion invited.

4. REGULATORY TECHNIQUES

Regulatory techniques are the most common and straight forward techniques. The following techniques may be adopted:

* One-way street
* Reversible street
* Reversible lane
* Turning movement restrictions
* Closing streets

4.1. One-Way Street

One-way streets are those where the vehicle movement is permitted in only one direction. They help in optimising the road capacity and minimising conflicts, which ultimately result in better traffic flow and safety. It also simplifies traffic operations at intersections, and reduces delays to moving traffic. A typical layout of one-way street operation is shown in Fig 1.

The following points need careful consideration before implementation of one-way street system:

(i) The one-way system is best suited for the network that has a grid pattern i.e. availability of parallel roads with evenly spaced cross roads connecting them.

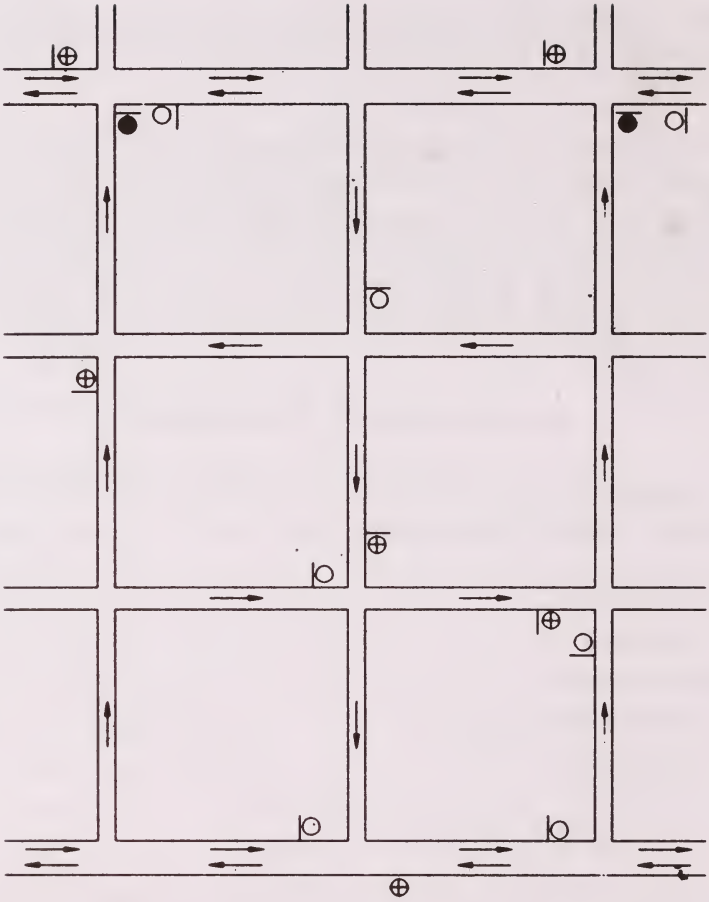


Fig. 1. Typical layout of one-way street system

The distance between such complementary streets should not normally exceed 300 metres. In the absence of parallel streets the travel distances may increase substantially.

(ii) Unless complementary roads with reasonably parallel alignment are available, one-way system should not be normally resorted to. As a rule of thumb, it is desirable to ensure that the extra travel distance resulting from one-way system does not normally exceed 30 per cent of the original.

(iii) The complementary streets so chosen should not have mixed land use.

(iv) Proper care should be taken to study the pattern of the displaced traffic (as a result of the one-way system) as it would have a tendency to resort to rat-runs through residential areas in order to aviod longer detour. In such situations sufficient speed breakers/barriers should be installed in the residential area to discourage such short cuts.

(v) Abrupt ending of one-way street should be avoided. If necessary, the one-way system can be extended beyond the earlier intended point. The adjacent areas, where the displaced traffic is likely to have implications, should also be studied in conjunction with the area under consideration.

(vi) As far as possible, a particular street should be continued one-way in the same direction, end to end, except under special circumstances.

(vii) Good signage and lane markings are the main pre-requisites of any one-way system. "No entry", "One-Way" and "No Right/Left Turn" boards should be conspicuously displayed at all strategic points, especially at the ends of the one-way street and at the meeting points of the cross roads.

(viii) It is always desirable to consider one-way system with other management techniques such as parking restrictions, loading and unloading restrictions, progressive signal system, locations of the bus stops, contra-flow bus lane, etc.

(ix) It is very essential to give adequate publicity well before the introduction of the one-way system by distributing leaflets, publicity through press, posters at strategic places, etc. giving clear cut details of the proposed circulation system. During the experimental stage, a number of police personnel should be detailed at strategic places to politely guide the users who might get confused in the initial stage.

(x) As far as possible, the one-way system should always be experimented on Fridays so that whatever confusion is witnessed on the first day can be corrected during the next two days which are lean traffic days.

4.2. **Reversible Street**

This technique is useful in situations having uni-directional peak traffic pattern so that an important street is made one-way in the peak

direction in the morning and vice-versa in the evening with a view to optimising the flow of traffic during peak-time.

(i) This technique is, however, useful only if there is another parallel street available in close proximity to accommodate the opposite traffic.

(ii) The reversible one-way system is advantageous only if the volume of traffic in the peak direction is nearly twice the one moving in the lean direction.

(iii) It is preferable to control the operation of reversible street with the help of a traffic signal. The Green signal indicates the direction of flow, as per the time plan and prevents accidents. The direction change over time is the most crucial period. It would be, therefore, advisable to post a traffic constable during the transition period.

(iv) Adequate number of signs should be conspicuously displayed indicating the correct direction and time.

(v) The reversible street should be retained one-way even during the night in the same direction as in the evening. Too many directional changes are not desirable.

(vi) Adequate publicity is essential to make the public aware of the direction and time of operation.

4.3. Reversible Lane

This technique ensures apportioning of the carriageway between two directions of travel in a manner that matches the volume of traffic. Additional lane(s) can be allotted to the peak flow direction by squeezing width of the carriageway meant for the opposite traffic so as to optimise the utilisation of road space.

A typical reversible lane is shown in the Photograph 1 and Fig. 2.

(i) This technique should normally not be implemented unless the total width of the road is more than 4 lanes; since on smaller roads, snatching of a lane would leave very little space for the lean direction flow that can cause serious bottlenecks in case of an accident, or breakdown, or halting of a bus at a stop.

(ii) Traffic cones should be used to delineate boundary of the additional area taken away from the opposite carriageway.

(iii) Signs showing the direction should be conspicuously displayed at both ends of the lane.

(iv) Traffic constables must be deployed at both ends of the street so as to ensure that a new driver to the city does not enter the wrong lanes.

Photo. 1

(v) At pedestrian crossings along the section of the operative lane, policemen should be deployed so as to prevent accidents and help safe crossing. The reversible lane should be painted continuous white with arrows showing both directions.

(vi) Proper care should be taken for bus stops and cross movements and traffic from side streets.

4.4. Turning Movement Restrictions

Ban on turning movements minimises conflicts at intersections, thus enhancing their capacity as well as safety. It also simplifies the traffic signal phases to minimise delays at the crowded intersections. It is very essential to consider alternative routes for diverting the affected traffic before banning any turn.

(i) Left turns are rarely banned unless an intersection has multiple arms or pedestrian flow across the street is very heavy.

(ii) As far as possible, free left turn at a signalised intersection should be avoided. If, at all, it has to be given, 'blinking amber' aspect must be incorporated to caution motorists to slow down. Cautionary sign indicating "free left turn" should also be conspicuously displayed for warning both the drivers and the pedestrians.

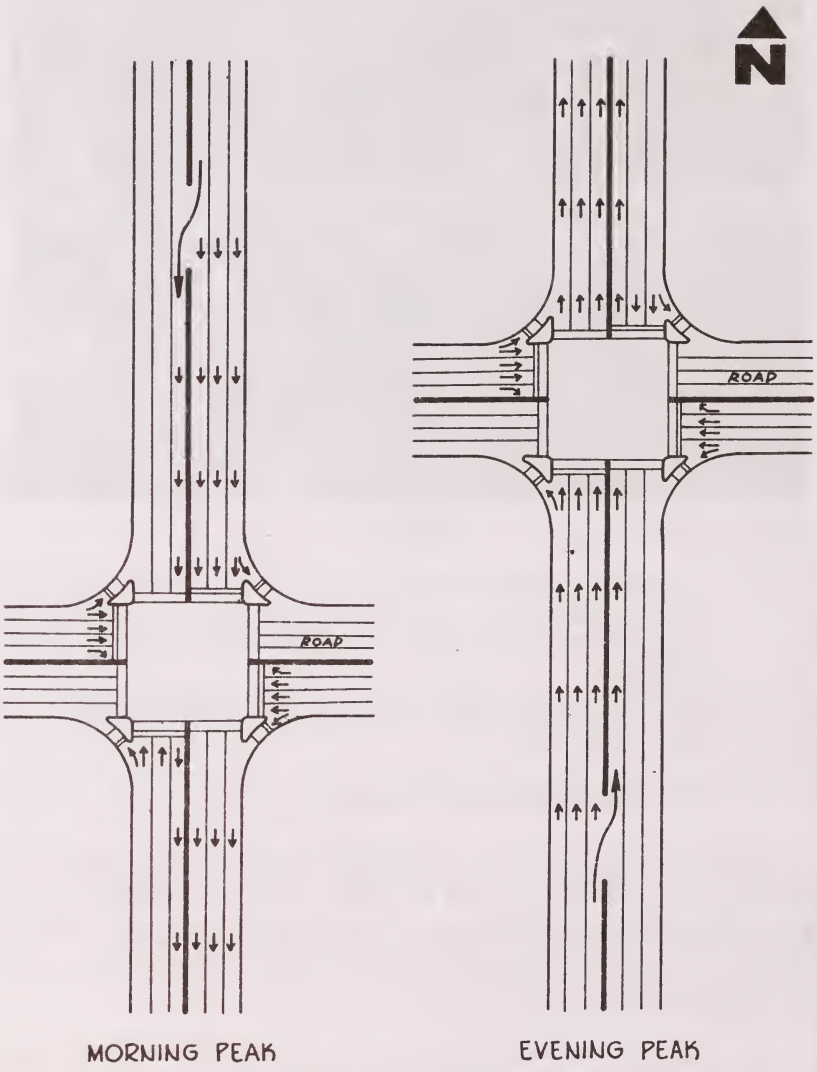


Fig. 2. Reversible lane

(iii) If there are two similar intersections at close distance on a major corridor, it shall be prudent to ban complementary turns at adjacent intersections so as to stagger the traffic load uniformly and minimising inconvenience to motorists.

(iv) There are three commonly used procedures through which the right turning

traffic can be re-routed:

(a) Diversion of the right turning movement to the left, before the congested intersection is what is known as G-turn and illustrated in Fig. 3(a).

(b) Diversion further along the road, so that the difficult right turnings from a minor road onto a major road takes place at a minor-intersection, as indicated in Fig. 3(b).

(c) Diversion to the left beyond the intersection, requiring three left turns. This is known as Q-turn and illustrated in Fig. 3(c).

(v) It is always desirable to ban U-turn, wherever possible, particularly on a major artery, a busy street, or a narrow road where geometrics and the road width do not permit U-turn in one manoeuvre.

4.5. Closing Side-Street

This technique envisages closure of side-street with a view to improving flow on the main street by minimising conflicts. It naturally enhances safety level as well. It helps in staggering the load at the complicated intersection, besides, reducing enforcement burden and even need for a signal. If there is a parking demand in such an area, the side lanes can be gainfully used; however, in that case, parking on the major street must be banned to improve its capacity. In the shopping areas, such cul-de-sac streets can be converted into pedestrian plazas.

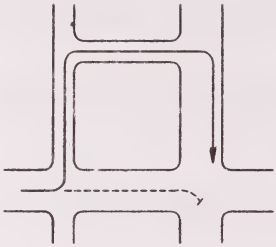
However, if a side street is to be closed in an area where easy access is not available nearby, it would be better to close the streets with a chain instead of using permanent physical barrier so that access to emergency vehicles is available during any exigency, Fig. 4.

5. TRAFFIC CONTROL DEVICES

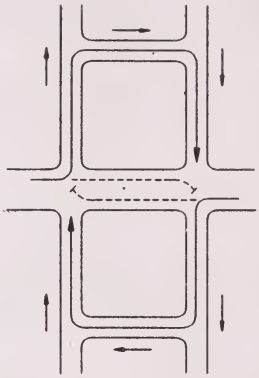
Traffic Control Devices are all signs, signals, markings, and devices placed on or adjacent to a street or highway (by authority of a public body or official having jurisdiction) to regulate, warn, or guide traffic.

(a) Important Requirements of Traffic Control Devices

To be effective, traffic control devices must meet the following

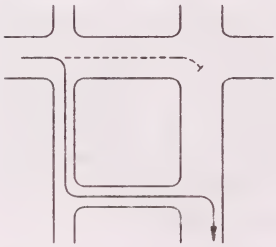


1. LEFT TURN BEFORE REACHING INTERSECTION

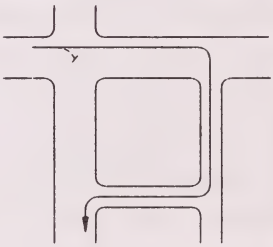


2. AS 1. BUT WHERE ONE WAY ROADS CROSS A MAIN ROAD

(a) G-TURN

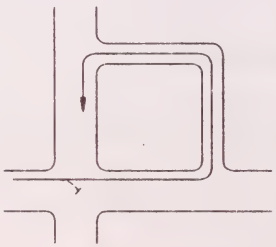


3. BY A RIGHT TURN BEFORE REACHING INTERSECTION



4. BY A RIGHT TURN AFTER PEACHING INTERSECTION

(b) T-TURN



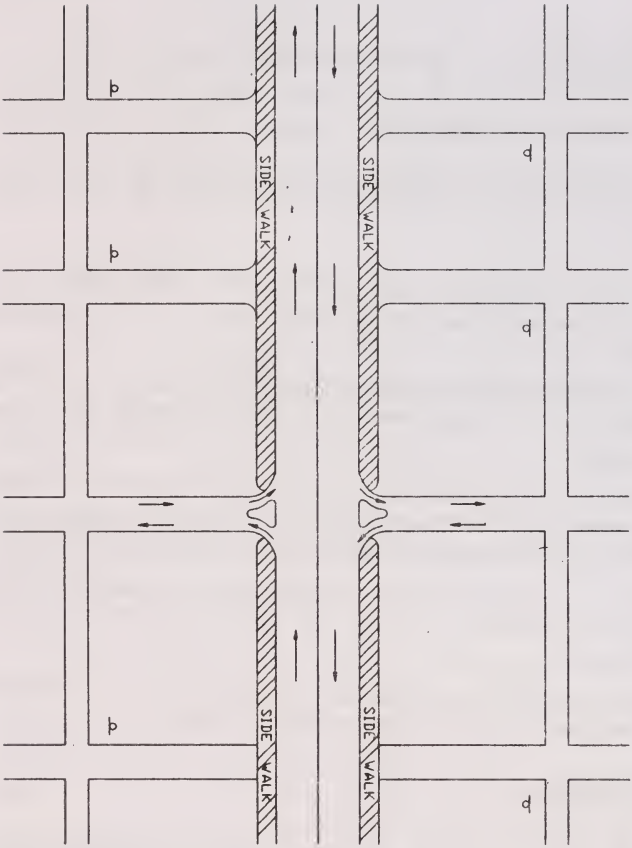
DENOTES DENIED ROUTE

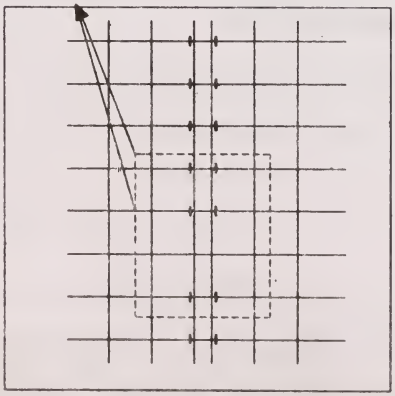
DENOTES ALTERNATIVE ROUTE

5. BY THREE LEFT TURNS AFTER PASSING AN INTERSECTION

(c) Q-TURN

Fig. 3. Re-routing right turning traffic





LEGEND:-

— NO THROUGH ROAD

Fig. 4. Closing side streets

requirements.

* Catch the eye
* Command respect
* Convey the meaning/message

These requirements are achieved by ensuring the following five basic factors:

(i) *Design:* The combination of physical features such as size, colours, and shape should be such as to stand out and attract attention and convey the message clearly.

(ii) *Placement:* The installation of devices should be within the cones of vision of road-users so that it not only attracts the attention but also allows sufficient time for response.

(iii) *Operation:* As far as possible, the device must be designed and operated in a uniform and consistent manner so that the road-user can properly respond to it, based on his previous exposure to similar traffic control situations.

(iv) *Maintenance:* A device should be of high standard and adequately maintained to retain its legibility and visibility. This would command the respect of road-users.

(v) *Uniformity:* All devices must adhere to uniform specifications so that an average road-user can recognise and understand them easily.

(b) Classification

The traffic control devices may be classified into the following four main categories:

* Traffic signs
* Road markings
* Traffic signals
* Miscellaneous traffic control devices

5.1. Traffic Signs

Traffic signs are traffic control devices, whether fixed or portable, for conveying warning, information, requirements, restrictions or

prohibitions of any description specified by law/regulation, to the traffic on roads.

They fall into three broad categories viz. regulatory signs, warning signs and informative signs. As far as possible, traffic signs should communicate their message by graphic symbols. The size, colour combination and other standards for all road traffic signs have been given in "Code of Practice for Road Signs" (IRC:67-1977).

5.2. **Road Markings**

Road markings are probably the simplest, cheapest and most cost-effective. They can regulate, warn or guide traffic through lines, symbols or words. They also serve as symbolic barriers for separating the opposing streams of traffic; provide information for turning movements, special zones; and so on. They are very important at intersections to guide pedestrians across the carriageway and thus promote road safety. They not only contribute to road safety but also to the comfort and confidence of the driver.

Road marking must attract immediate attention, have adequate legibility for the approach conditions and convey a clear meaning so as to provide sufficient time for the driver to respond. Road markings mainly include central line; traffic lanes; pedestrian crossings; stop lines; no overtaking zones; carriageway width reduction and transition markings; pavement edge lines; route direction arrows; bus stops; parking space limits; yellow box to indicate no-stopping area, etc.

The Indian Roads Congress has developed uniform standards for road markings and presented in "Code of Practice for Road Markings (with paints)" (IRC:35-1970). For details, this document may be referred to.

5.3. **Traffic Signals**

A traffic signal is traffic control device operated manually, electrically or mechanically by which traffic is alternately directed to stop and proceed. Traffic signals, when properly designed, located

and operated, achieve one or more of the following:

(i) effect orderly traffic movement;

(ii) provide for the continuous flow of traffic in small platoons, through proper coordination at a definite speed along a particular route;

(iii) allow other vehicles and pedestrians to cross a heavy traffic stream;

(iv) reduce incidence of right-angle and pedestrian accidents;

(v) signals have standard indications which all drivers can follow easily, and are understood more easily and effectively at night or in foggy weather than the hand signals of a policeman;

(vi) control traffic more economically than by manual methods.

Traffic signals can be operated either in isolation which is more common or as coordinated parts of the linked signal system. It is desirable to link signals on a principal traffic route in order to reduce delay and the number of stops at the signals. This is generally accomplished through a master controller that determines the phasing of signals at each intersection of the system. With micro-processor technology, this system can be so programmed as to provide preferential treatment to the major flow at peak-flow times, or optimise the traffic movements in the entire area based on various computer-based optimisation models (Area Traffic Control System).

The guidelines for design, installation and other requirements of traffic signals have been stipulated in IRC:93-1985; ''Guidelines on Design and Installation of Road Traffic Signals''.

5.4. Miscellaneous Traffic Control Devices

The traffic control devices described in para 5.1 to 5.3 are normally supplemented by the following devices for improving traffic flow and enhancing road safety:

* Barricades
* Traffic cones
* Drums and rope
* Box junction

* Central refuges
* Speed-breakers
* Lighted traffic bollards
* Reflective devices

5.4.1. **Barricades:** The barricades are used to warn and alert drivers of hazards created by construction or maintenance activities on or around carriageway/footpath. The following requirements must be borne in mind:

(i) These barricades could be of wood, fibre-glass, P.V.C. or mild steel.

(ii) Barricades are painted with red and white stripes sloping downward at an angle of 45° in the direction along which the traffic is to pass.

(iii) If the lane/road is closed to vehicles, vertical red and white stripes are used.

(iv) The width of each stripe should not be less than 20 cm.

(v) The barricades should be invariably reflectorised and/or equipped with lighting devices for night-time visibility.

(vi) Barricades should be provided .o cordon off the excavated area.

(vii) While red light is used at either end of the protected area (on the barricade across the road), yellow light should be put at regular intervals along the longitudinal barricades to guide the motorists along the diverted path. While red light should be a steady indication, the yellow light should be on flashing mode, preferably with directional arrows. Solar power lighting devices may be used for this purpose as is the practice in other countries.

A typical barricade is shown in Photograph 2, while its dimensions are indicated in Fig. 5.

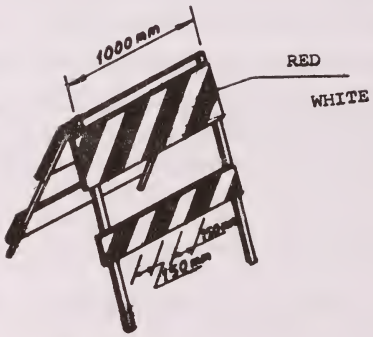
5.4.2 **Traffic cones/bats:** These are portable temporary devices used to delineate the diverted path either around an obstacle or to create additional space for traffic movement. They should have the following important features:

(i) They are generally conical in shape with a minimum height of 75 cm and maximum of 90 cm Bat shape devices are also found very effective.

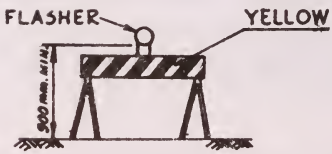
(ii) They should have a broader and heavy base for stability so that they do not fall down easily.

(iii) Cones are of red colour with white bands. Bats are of white colour with diagonal stripes in red colour.

Photo. 2



BARRICADE



PORTABLE FLASHER SUPPORT

Fig. 5. Barricades

(iv) Though these devices could be of fibre glass, plastic or special rubber, they must be capable of withstanding impact without damage to themselves or to vehicles.

(v) For night use they should be either reflectorised or equipped with lighting devices.

A typical traffic cone and bat are shown in Photograph 3. Their dimensions are indicated in Fig. 6.

5.4.3. **Drums:** Barrels or drums are normally used as a cheap alternative to traffic cones or protective barricades. As the enforcement authorities (Traffic Police) have easy access to such barrels (confiscated

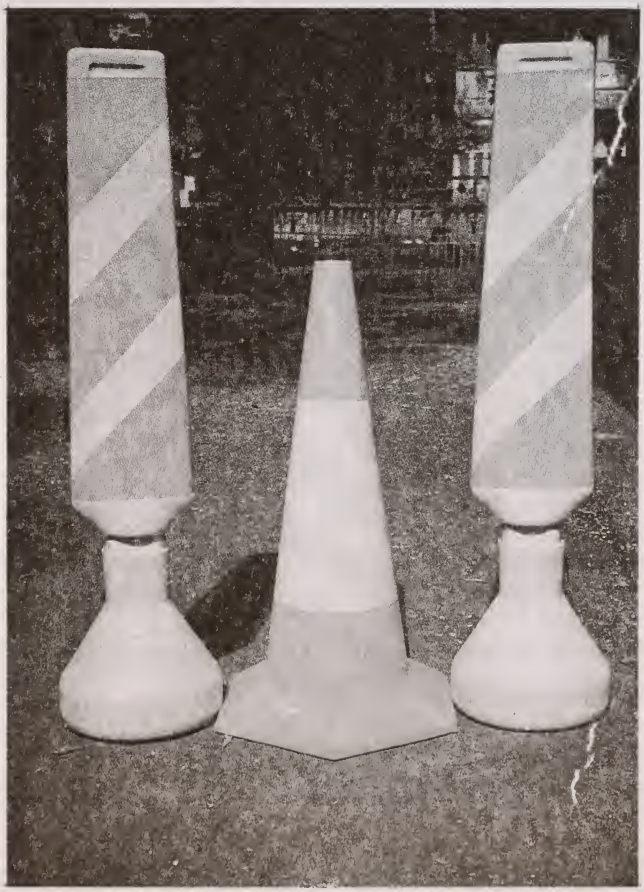


Photo. 3

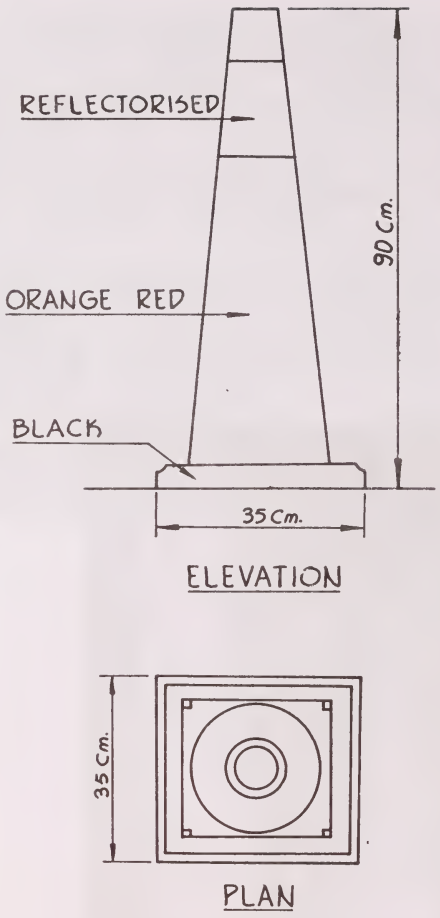


Fig. 6(a). Type design for reflective traffic cone

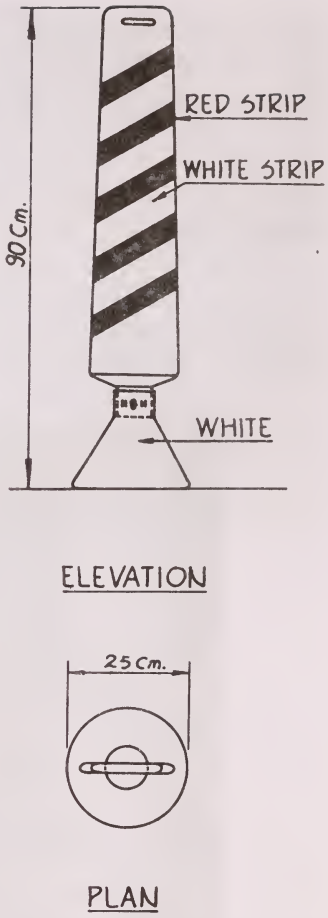


Fig. 6(b). High density traffic barrier

in prohibition raids etc.) they are, sometimes, used for cordoning the construction site or channelising the traffic.

A typical alignment of drums is shown in Photograph 4 and dimensions are indicated in Fig. 7.

A row of drums can be effectively used at night to mark the edge

Photo. 4

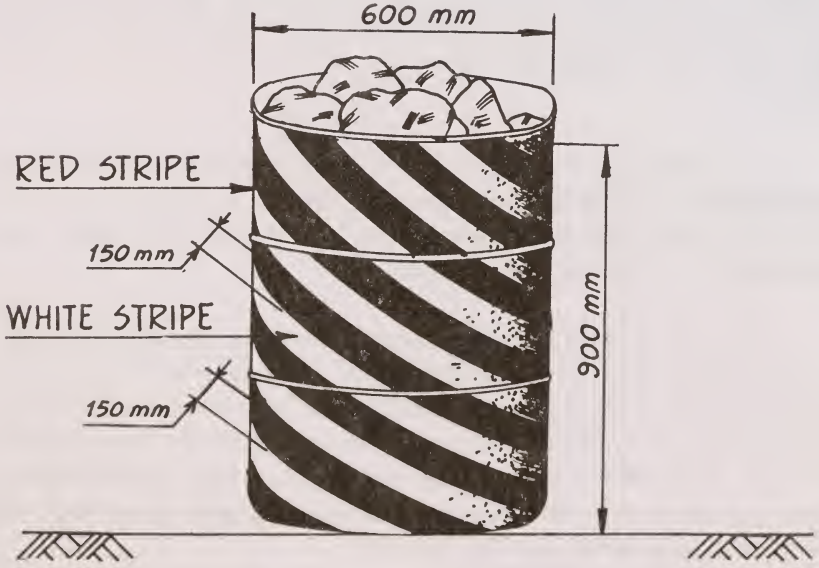


Fig. 7. Drums for temporary work

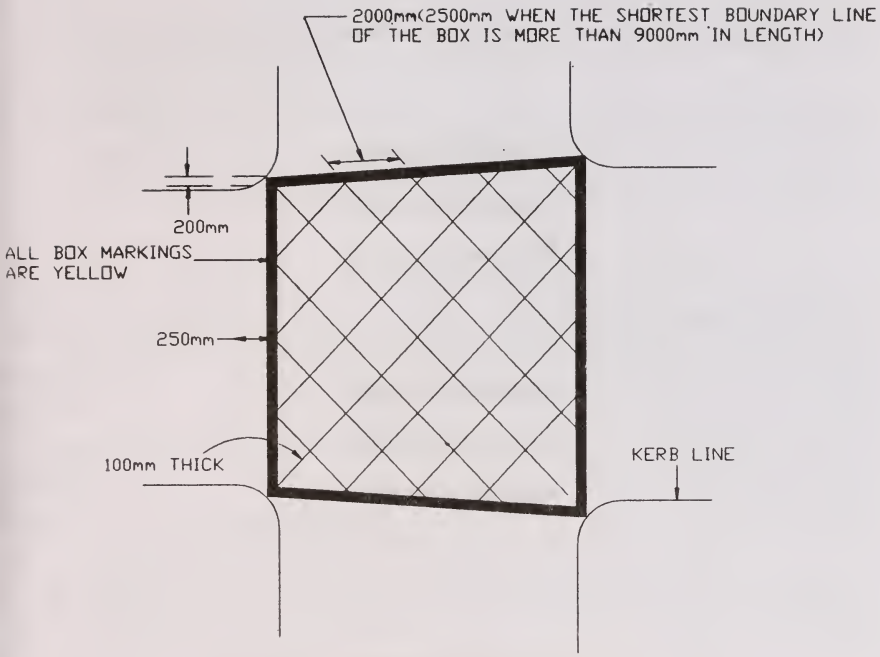
of pavement. During working hours, the same barrels can be moved on to the pavement to provide working room for the construction activity. Moreover, as they give the appearance of being formidable obstacles, they command the respect of drivers, and yet they do not cause serious damage to a vehicle in the event of being struck against. However, barrels are bulky and not readily transportable. Drums should be normally painted with horizontal, circumferential, red and white reflectorized stripes. They are generally 90 cm in height and have, at least, two red and two white stripes that are 10 to 20 cm wide. These are generally metal drums of 125 to 250 litres capacity. A flashing warning light is used when drums are used singly, and steady warning lights when used in a series for channelisation.

5.4.4. **Box junction:** The critical junctions/areas are marked with yellow crossed diagonal lines in the form of a box to indicate the area where vehicles must not become stationary even for a short while. Regulations are introduced by legal notifications to prohibit drivers from entering such area even if the signal light is green, unless they are sure they will be able to clear the area immediately. This ensures that in event of heavy traffic ahead neither the junction is choked nor the cross-traffic and pedestrian movement across the road is adversely affected.

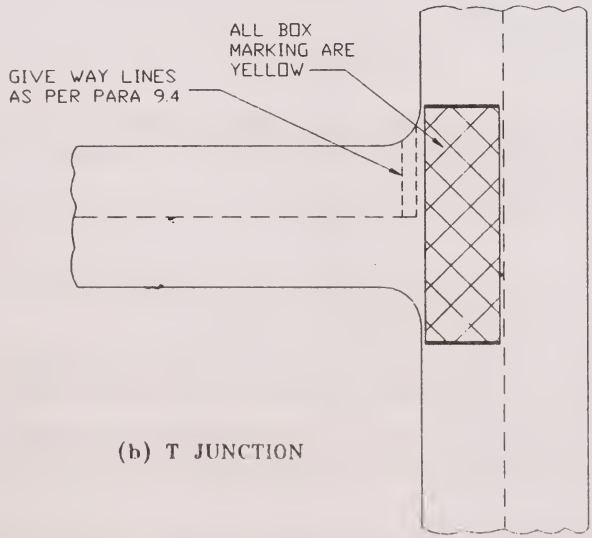
It is absolutely imperative to display sign-boards adequately and conspicuously to forewarn motorists about the box junction (Fig. 8). The width of crossed-diagonal lines should be 10 cm These lines must necessarily be of yellow colour alone.

5.4.5. **Central refuges:** The refuge island (Fig. 9) provides a place of safety for pedestrians to enable them to cross wide roads which, ordinarily, they could not have crossed at one time because of changing traffic signals or continuous stream of oncoming traffic from opposite direction. A typical use of the refuge is on roads where small number of people habitually cross at different points for one reason or the other. The important requirements are listed below:

(i) A pedestrian central refuge should have raised kerb and should not be less than 1.2 metres in width and 3.6 metres in length. Openings or dropped kerbs should be provided in the centre island to assist pedestrians.



(a) FOUR ARMED INTERSECTION



(b) T JUNCTION

Fig. 8. Typical box junctions

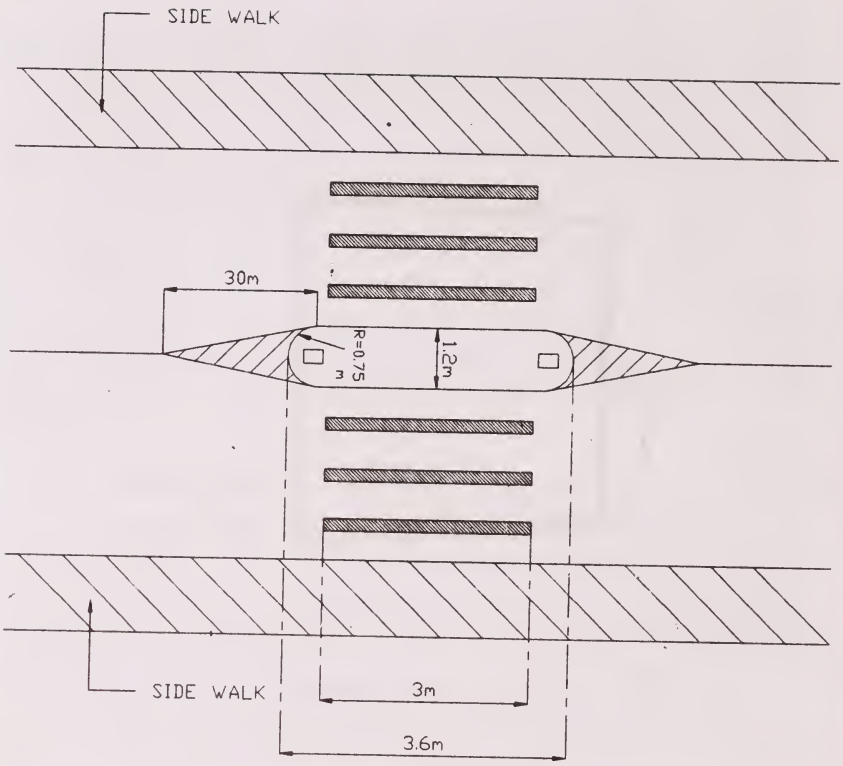


Fig. 9. Refuge island

(ii) The central refuge reduces the width of carriageway which can reduce vehicle speeds but sufficient width should be available for safe passage of the largest vehicles likely to use the road.

(iii) A refuge island should not be provided on a road which has width of less than 12 meters.

(iv) As far as possible, refuge island should not be installed in isolation; otherwise, it would be vulnerable to collision by vehicles.

(v) Parking and loading/unloading restrictions should be ordinarily considered on either side of the refuge island upto a distance of 50 metres on each side.

(vi) Lighted traffic bollards must be fixed at each end of the refuge island so that vehicles are forewarned of the impending obstruction on the road during night time.

(vii) The lighted traffic bollard should be sufficiently high and wide to be conspicuous; the ideal height is 1.2 metres.

(viii) Zebra crossing may be considered at such refuge island across the road.

(ix) The refuge island should be invariably painted with black and white stripes so as to be conspicuous from a distance.

(x) Where the pedestrian traffic is very heavy, overhead halogen lights are also recommended so as to make the pedestrian crossings not only conspicuous but also to have a psychological effect on motorists about something important. It automatically commands respect from motorists because pedestrians are visible even from a good distance.

5.4.6. **Speed-breakers:** Speed-breakers are traffic control devices which alert the driver of a change in conditions and break speed of a vehicles. They can consist of small asphalt stripes placed on the pavement (called rumble strips) or be uniformly but gradually raised surface with horizontal top. It is very essential to adhere to the Specifications "Tentative Guidelines on the Provision of Speed-Breakers for Control of Vehicular Speeds on Minor Roads (IRC:99-1988)". The following features must be borne in mind:

(i) Speed-breakers should not be ordinarily installed on major roads where traffic volume is very heavy. They are mainly constructed on streets with dead-end, crowded residential areas with local traffic, or on sharp curves where frequent accidents take place.

(ii) On approaches to railway crossings or weak/narrow bridges, rumble strips should be provided (instead of speed breakers). These should be marked with thermo plastic paint and supplemented by warning/speed limit signs on approaches.

(iii) If, the size and shape of speed breakers do not conform to the Specifications contained in IRC:99-1988 they may be hazardous to traffic.

(iv) The speed-breakers must be invariably painted with black and white bands, as per IRC:99-1988.

(v) Warning sign-boards indicating the presence of speed-breaker, must be conspicuously displayed, at least 40 meters ahead on either side of the device.

5.4.7. **Lighted traffic bollards:** A lighted traffic bollard is a lighted device installed on a channeliser/island to forewarn motorists of the impending obstruction threat. It also indicates the direction of the traffic flow. The following requirements are essential.

(i) The height of such a bollard should be about 1.2 metres, above the ground level.

(ii) The bollard has a colour combination of white, blue and yellow. The area of

exposure showing the directional arrow should be a minimum of 30 cm square (or of 30 cm diameter if it is circular). The remaining lower part of the bollard is lemon yellow/traffic yellow.

(iii) The bollard should be illuminated inside by incandescent or flourescent light.

(iv) As the bollard is vulnerable to accident it should be made of material such as plastic so as to avoid injuries.

A typical lighted bollard is shown in Photograph 5 and its dimensions are given in Fig.10.

Photo. 5

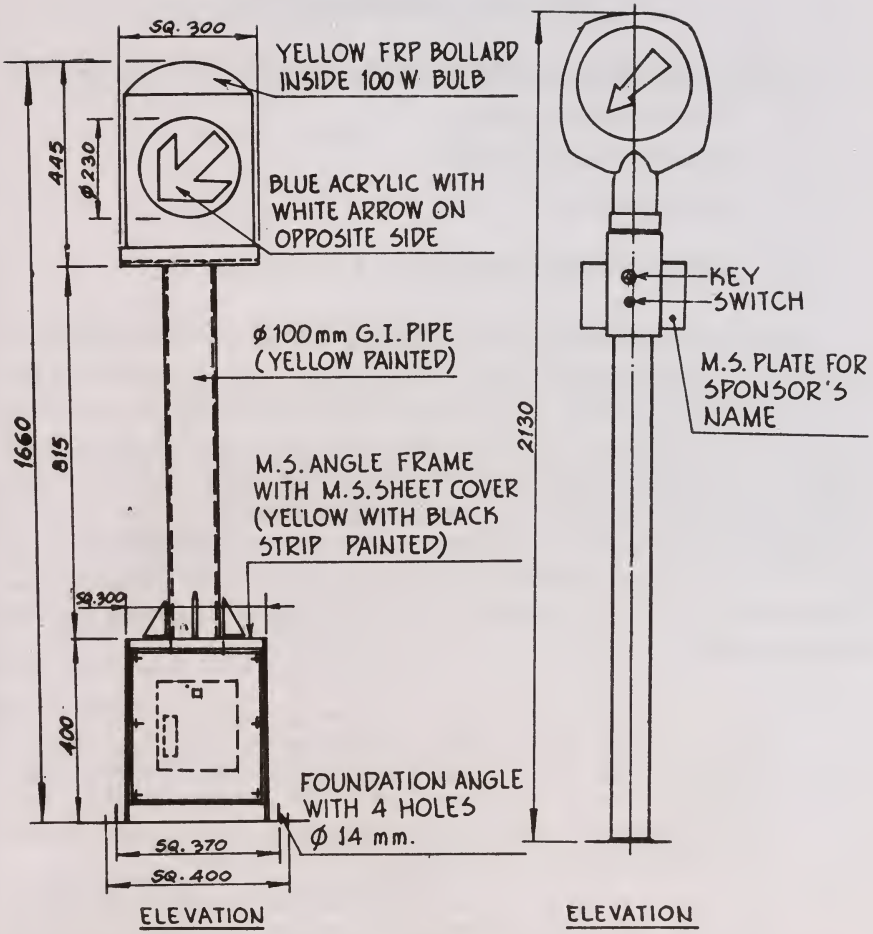


Fig. 10. Traffic bollard (all dimensions are in mm)

5.4.8. **Reflective devices:** Reflective devices such as cat's eye, peli stud, delineators, island markers are placed on the pavement along the kerb and dividers to warn and guide motorists during night time. The underlying principle is that when head-light falls on such devices, they reflect light and become self illuminating and visible. These are recommended for kerb line, guard stones, central dividers, refuge island, channelisers, speed-breakers, on sharp curves and along central median (without physical dividers).

6. TRAFFIC SEGREGATION

Traffic segregation techniques can be classified into two groups:

* Vehicle-Vehicle Segregation
* Pedestrian-Vehicle Segregation
* Time Segregation.

6.1. Vehicle-Vehicle Segregation Techniques

Segregation principles are being applied all over the world to separate the slow-moving traffic from the fast one, especially in the Central Business District. This can be achieved simply by imposing certain legal restrictions. The lorry traffic, wherever possible, is confined to the outer areas and restrictions imposed on their movements in the city limits during peak periods. On major roads where sufficient width is available, separate lanes are designed for fast and slow vehicles by using painted lines or physical dividers. In some cases, even the minimum and maximum speeds are also indicated. The following requirements must be borne in mind.

(i) Central dividers are not desirable on carriageways of width less than 18 meters, unless otherwise found essential for safety reasons. In any case, minimum carriageway width of 7.5m on either side for facilitating 2+2 effective lanes, separated by a divider of minimum width of 1.2 m (i.e. total carriageway width of 16.2m) must be available before considering the physical central dividers: otherwise, continuous double lines be painted in the centre.

(ii) The physical central dividers are not recommended on bridges and flyovers, unless the width of carriageway in each direction is 7.5 metres. It must be ensured that the effective carriageway width at the approaches is uniformally carried through the bridge/flyover. However, continuous double lines should be painted to separate the opposing traffic; yellow paint would be more conspicuous.

(iii) The central dividers/verge should have adequate width so that it serves as refuges for pedestrians to take shelter and can also accommodate other required road furniture such as signal and/or lighting posts.

(iv) Where inadequate central verge is being provided, it is desirable to do landscaping so that glare of headlights is considerably reduced at night. However, while planting trees or shrubs, care must be taken such that trees do not obscure vision of drivers, especially near the intersections, pedestrian crossings and median opening. It is recommended that, at least 15 meters of the central verge from each end of the opening is kept entirely clear.

6.2. Pedestrian Vehicle Segregation Techniques

These techniques can be classified into the following three categories:

* Longitudinal segregation
* Lateral segregation
* Total segregation
* Spatial segregation

6.2.1. Longitudinal segregation

(i) This mainly includes construction of side-walks/footpaths. The Specifications are given in IRC:103-1988 "Guidelines for Pedestrian Facilities".

(ii) Raised footpaths are always preferable. However, where not possible, it is absolutely essential to segregate footpath from the carriageway by using guard stones and railings. Railings along footpath/central dividers are particularly important near the intersections so as to force pedestrians to cross only at the designated zebra markings.

6.2.2. **Lateral segregation:** Lateral segregation is mainly done to ensure safe crossing of pedestrians across the path of vehicles. It includes the following:

(i) Zebra Crossing: IRC:35-1970 "Code of Practice for Road Markings (with paints)" may be referred for details.

(ii) Refuge island (discussed in para 5.4.5 of these guidelines)

(iii) Railings along central dividers

Such railings are provided on those roads where pedestrians tend to cross erratically, especially in the congested areas.

(iv) Pederstrian traffic signal (IRC:93-1985, "Guidelines on Design and Installation of Road Traffic Signals" may be referred for details)

(v) Foot-over bridges

(vi) Pedestrian subways

(vii) Sky-walks

A typical foot-over bridge, pedestrian subway and skywalk are shown in Photographs 6, 7 and 8 respectively.

Photo. 6

Photo. 7

Photo. 8

6.2.3. **Total segregation:** The most ideal situation is, however, complete pedestrianisation. The streets with intense pedestrian pressure could be declared 'pedestrian only streets.' The restrictions on the movement of vehicles may be imposed either during the pedestrian peak-time only, or throughout the day, depending upon the local situation. Where several such streets meet, the total area may be converted into ''Pedestrian Only'' area commonly known as 'pedestrian plaza' or 'pedestrian precinct' or 'pedestrian mall'. The following points must be borne in mind while implementing such pedestrian schemes:

(i) All such precincts must have arrangement for easy access to the emergency vehicles like fire-brigade, ambulance.

(ii) Goods vehicles must be provided reasonable access for loading and unloadng during certain hours.

(iii) Adequate parking space must be available in the vicinity so that the walking distance is resonable and the business in the area is not adversely affected.

(iv) Alternative routes are available for diverting the vehicular traffic thus displaced.

(v) Bus service should not be adversely affected and passengers must be brought within a reasonable walking distance.

(vi) The encroachments, particularly hawkers/vendors, are adequately checked by the authorities.

(vii) The boundaries of pedestrian areas must be clearly demarcated and warning signs both for pedestrians and motorists conspicuously displayed on such boundaries to avoid confusion and improve safety. These warnings are expected to perform the following functions.

* Indicate to the pedestrian that he is leaving an area where he enjoyed complete freedom of movement or vice-versa.

* Inform motorists that they are entering a zone which permits them only restricted freedom of movement in terms of time, space etc.

It is, therefore, recommended that the entire pedestrian zone is created at a level different than the motorable roads and/or paved with special material so as to be prominent.

6.2.4. **Spatial segregation:** There are special segregation techniques for the cyclists, buses, etc.

(i) Bicycles tracks have been dealt within IRC:11-1962, ''Recommended Practice

for the Design and Layout of Cycle Tracks''. The cycle tracks and side walks should not be at the same level; a level difference of 10-15 cm is desirable in the interest of pedestrian safety. The boundary of the cycle track should be clearly marked with white paint.

(ii) Bus segregation is achieved through bus lanes and bus only streets. Bus lanes and bus only streets are discussed later under ''Bus Priority Techniques''.

6.3. **Time Segregation**

Time segregation is meant to regulate the movement of vehicles by time of the day. For example the heavy vehicles are not allowed during peak hours in busy areas.

7. DEMAND MANAGEMENT TECHNIQUES

The planning and transport policies should not be based on completely unrestricted use of the motor vehicle. Emphasis needs to be laid on the management of urban transport system to ensure movement of more people in fewer vehicles in least time, while preserving and improving the environment. Therefore extravagant use of low-occupancy private cars especially in the busy and congested areas should be limited. This can be achieved through traffic restraint and demand management techniques which inhibit or restrict car use in city centre.

The underlying principle is that the benefits a road user obtains from a particular journey is more than the price that he would be prepared to pay in order to make the journey. But, if the price charged for making a trip was gradually increased, then the point would be reached at which the trip maker would either decide not to go, or to go by another mode of transport, or at another time. The principles of demand and supply become very relevant in this context. The demand for use of road network in a particular area, can be curtailed by raising price, directly or indirectly, by levying taxes on the use of public roads and parking places, etc. In other words, those who are responsible for causing traffic congestion should be made to pay extra.

Basically these restraint methods should be:

(i) Flexible, to meet differing and changing needs;

(ii) efficient, so that undue restriction is avoided;

(iii) selective, by type, area and time of journey;

(iv) fair, and acceptable to the community at large;

(v) simple, to administer and enforce, and not open to abuse;

(vi) easy to understand and to follow for both casual and regular travellers.

Traffic restraint can be achieved by two methods:

* Indirect methods
* Direct methods

7.1. Indirect Methods

One of the major thrusts of the indirect methods is in the area of public transport option. The motorists are encouraged to switch over to public transport by making the latter cheap, convenient, comfortable, readily available, and highly efficient. Simultaneously, restraints are imposed on the movement of the personalised transport which may include:

* banning of a particular class of vehicles at certain time and/or in certain areas;
* auto-free zones where vehicles are totally prohibited;
* special bus lanes and streets where space is reserved exclusively for public buses and emergency vehicles;
* prohibition of entry and turns, and limited access facilities.

Bus priority techniques along with restrictions on the movement of the personalised transport through regulatory techniques yield the intended results.

7.2. Direct Methods

The following techniques are considered under this sub-head.

* Parking controls
* Road and bridge tolls
* Road pricing
* Odd-even auto traffic restraint
* Staggering of office hours.

7.2.1. **Parking controls:** Parking controls are the most widely used form of restraint in almost all the cities of the world. These may include parking restrictions along major arteries, either 24 hours or during the peak time, depending upon the local conditions and requirements. Lately, parking pricing is becoming very popular, as it not only achieves the objectives of reducing traffic congestion but also earns revenue. It also ensures that car spaces are not misused by a few for garaging, but are put to optimum use for those who need them for the absolute minimum time. Parking controls achieve the following:

* make efficient use of parking spaces;
* recover the cost of providing parking spaces;
* reduce congestion and prevent obstruction to moving vehicles;

The parking pricing is effected through the following methods.

(i) **Off-Street Pay and Park Areas**

Off-street parking is created either in the designated parking lots (however, selection should be done intelligently) or by constructing special multi-storey buildings or under-ground parking garages. Tariff is collected either manually or by using electronic/ mechanical aids.

(ii) **On-Steert Parking Meters**

Where off-street parking facilities are limited while the demand for parking is very high, parking meters may be installed along the kerb line of the roads where such parking would not hamper the traffic flow. Such schemes are generally implemented in commercial/ shopping areas.

(iii) **Park-and-Ride System**

Large off-street parking areas are created to enable motorists to park their vehicles and switch over to the public transport like buses, trains, trams, etc. for onward journey to their work places, so that the traffic volume along major arteries leading to the Central Business Districts (C.B.D.) as well as the road network within the C.B.D. is substantially reduced.

7.2.1.1. **Requirements:** It may be, however, remembered that motorists would tend to park on other roads in the vicinity of the area under parking control. In other words, they are likely to foul other roads and areas where congestion may consequently increase. It is, therefore,

necessary to impose parking restrictions on all streets adjacent to the areas where parking pricing has been introduced. Good parking enforcement is the pre-requisite of the success of this system, which may be ensured by employing traffic wardens, traffic policemen, towing cranes, etc.

Parking controls reduce the peak-period traffic and improve the general flow along such streets. As parking controls are not applicable for the through-traffic, the latter is encouraged to use such areas where movement has now improved. In other words, while the congestion may drop temporarily, the through-traffic from other areas is likely to be attracted to such roads.

7.2.2. **Road and bridge tolls:** Tolls are generally collected for the use of highways, bridges, tunnels and ferries. Most of these tolls are introduced to recover the cost of the facilities so provided. As alternative routes are available to motorists, this technique imposes traffic restraint only to some extent and may not prove very effective as a restraint measure.

7.2.3. **Road pricing:** It is a technique that requires drivers of certain categories of vehicles to purchase special licenses to use such vehicles at specified times (generally peak-period) in designated areas (generally the Central Business District). This technique, therefore, has an advantage over the parking control technique in as much that it affects moving vehicles as well. It is based on the principle that vehicles that cause congestion in the busy office and commercial areas must be made to pay for it. Public buses, school buses and emergency vehicles are normally exempted from these restrictions.

The following requirements must be borne in mind while implementing such schemes:

(i) The area in which restrictions are intended should be clearly defined by proper boundary signs.

(ii) The restricted zone must have the minimum entry points for effective enforcement.

(iii) Drivers entering the zone should display the licence on the wind screen.

(iv) Such licences should be easily available at places like post offices, petrol pumps, etc.

(v) This system requires good and effective enforcement so that drivers are not able to cheat.

(vi) The design of the licences should be such that it attracts immediate attention and cannot be easily forged.

(vii) Public acceptance of scheme, specially where mixed landuse of commercial and residences exist is necessary.

(viii) The road pricing can be varied with time of the day, but may be effected only during peak hours.

(ix) A pre-requisite for the success of such road pricing technique is the availability of efficient, comfortable, cheap and convenient public transport system to attract the affluent car-owners.

Such techniques ensure that people either pool their vehicles, or use public transport, or change their journey routes or stagger journey time to avoid entry through the restricted zones. This in turn, reduces traffic congestion and accidents, and improves the environment besides saving precious fuel.

7.2.4. **Odd-even auto restrictions:** This technique envisages restriction on private vehicles which have licence numbers beginning with an even number from using the main arterials and certain designated areas during certain days say on Mondays, Wednesdays and Fridays. Similarly, those beginning with an odd number are restricted on other days viz. Tuesdays and Thursdays. The restrictions can also be imposed with reference to odd and even dates, instead of days of the week; Saturdays and Sundays are generally excluded because of lean traffic days.

7.2.5. **Staggering of office hours:** It is one of the latest transport demand management techniques being used in various advanced countries. It envisages level or even out of peak-hours transport demand through the staggering of office hours (opening and closing times).

As most offices and establishments open at about the same time, there is a heavy strain on the public transport and on the main arteries during peak hours. Therefore, the staggering of work hours for a longer period can help spread the peak-load and relieve the extreme overcrowding in buses, trains and trams, and congestion on the main arteries. Staggering does not reduce the total demand; it only evens out the demand to manageable proportions.

Though this technique is inexpensive and easily implementable, it is absolutely necessary to study the existing conditions and transport services schedules, their capacity limitations, origins and destinations of workers, their travelling times, the inter-dependence of various types of establishments, the need for certain core hours when all establishments should be working at normal full strength, their geographical locations, etc. The success of this scheme entails voluntary cooperation of the employers and the employees.

8. BUS PRIORITY TECHNIQUES

The priority for buses is mainly related to movement of people as opposed to movement of vehicles. The road space should be allocated to the competing transport modes on the basis of demand and their efficiency in terms of passenger carrying capacity. The main objective is to provide protection to buses from delays which are associated with traffic congestion. The bus which is delayed by congestion will find more passengers waiting at bus stops and will continue to loose time. The following bus will find fewer passengers at the stops and may, therefore, overtake the first one resulting in the familiar phenomenon of bunching. Consequently, the service on the whole line is disrupted. It is, therefore, necessary to accord priority to buses so as to make the public transport more efficient and attractive with a view to discouraging private motorists from bringing their personal vehicles on to roads, especially during peak-time.

The following techniques are generally used to provide the desired priority:

* Priority manoeuvres;
* Bus lanes;
* Bus precincts;

8.1. Priority Manoeuvres

It is a simple technique to give priority to buses by permitting them turning movements which are prohibited to other vehicles. This is often used as a part of one-way scheme or in conjunction with contra-flow bus

lane. However, this technique entails better enforcement so as to ensure that other vehicles do not violate thereby defeating the main objective. It is, therefore, necessary to fix sign-boards prominently, indicating, for example 'Right turn only for Buses'. It is also advisable to paint ''Bus only'' along with the right turning arrow on the carriageway.

8.2. Bus Lanes

Bus lanes are the most common form of bus priority techniques, when road space is set aside for buses either at a particular time or at all times. Such lanes can be either with-flow or contra-flow.

8.2.1. **With-flow bus lane:** A with-flow bus lane, (Fig. 11), is one where buses move along the direction of traffic. Such a special lane is created when a part of the road is exclusively reserved for buses. It is usually reserved along the kerb side, and in the centre in special circumstances. The central reservation is generally done on freeways/ expressways where bus stops are not frequent as the passengers are highly exposed to traffic in such lanes. Therefore, on arterial roads, where bus stops are frequent, reservation is made near the kerb side. Such bus lanes are usually in operation only during the morning and evening peak hours. These special lanes are sometimes made available to other High Occupancy Vehicles (HOV) as well, such as cars with minimum four persons, contract and school buses and emergency vehicles. This however, depends on the local conditions that vary from city to city. Such lanes are normally provided only if the frequency of buses is at least 60 per hour and number of passengers moved by these buses is at least 1.5 times the number carried by other vehicles in the same direction.

8.2.1.1. **Associated problems:** On most Indian roads, which are generally narrow and have a lot of mixed traffic, commercial establishments, taxi and auto-rickshaw stands, with-flow bus lanes may not prove a success. However, where bus frequency is very high and express bus service is also operative, such lanes may prove counter productive, as boarding and alighting at a bus stop may hold all buses behind unnecessarily. It is also very difficult to shift all taxi/auto-rickshaw stands to bylanes. As various encroachments, excavations, garbage dumps and other such impediments force pedestrians, many a times, to move on the carriageway,

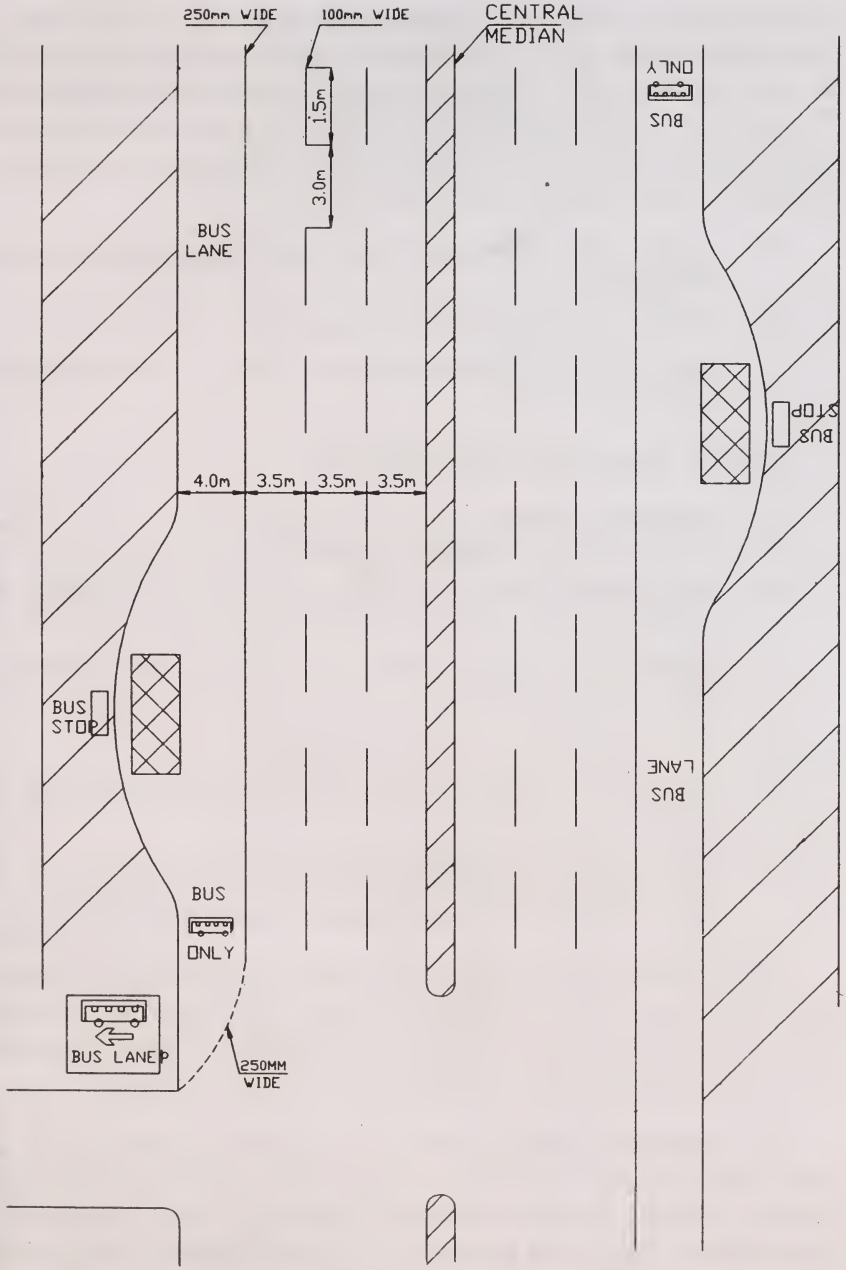


Fig. 11. With-flow bus lane

not only such bus lanes may not prove very useful but are also likely to pose safety hazards. These lanes may also curtail substantially the space for other vehicles on the carriageway, thus creating artificial traffic jams. The success of such special lanes presupposes good enforcement and would, therefore, call for large deployment of enforcement personnel all through the lane. The other problems may be:

(a) problem related to deliveries, thus inviting protest from traders and shopkeepers;

(b) problem of turning movements at intersections;

(c) delay at the stop along the lane when it is being used by several buses sharing the same stop.

8.2.1.2. **Introduction requirements**

(i) Availability of minimum two effective lanes (each 3.5 m wide) in addition to the reserved lane (minimum 4 m width);

(ii) Painting single continuous white lines (each 25 cm wide) to delineate the boundary;

(iii) Painting of bus symbol and arrows to conspicuously indicate the lane 'buses only';

(iv) Time of operation to be indicated on the lane;

(v) Sign-boards to be displayed prominently all along the lane, indicating the specific time of operation; and

(vi) Installation of red flasher lights at important junctions, especially where the lane is being discontinued (either for some distance or completely), and amber flasher at the beginning/intermittent entry points.

8.2.2. **Contra-flow bus lane:** It is a lane on a one-way road, solely reserved for buses that are permitted to drive against the flow of other vehicles so that direct route of buses is not hampered by the introduction of the one-way system and commuters are not inconvenienced.

The contra-flow bus lane, (Fig. 12), should not be less than 4 m wide. Such bus lanes are usually in operation for 24 hours to avoid confusion. All other requirements are the same as spelt out in case of with-flow bus lanes. Contra-flow bus lanes are generally introduced only when flow exceeds 30 buses an hour. They are also made available to emergency vehicles and sometimes even to school buses.

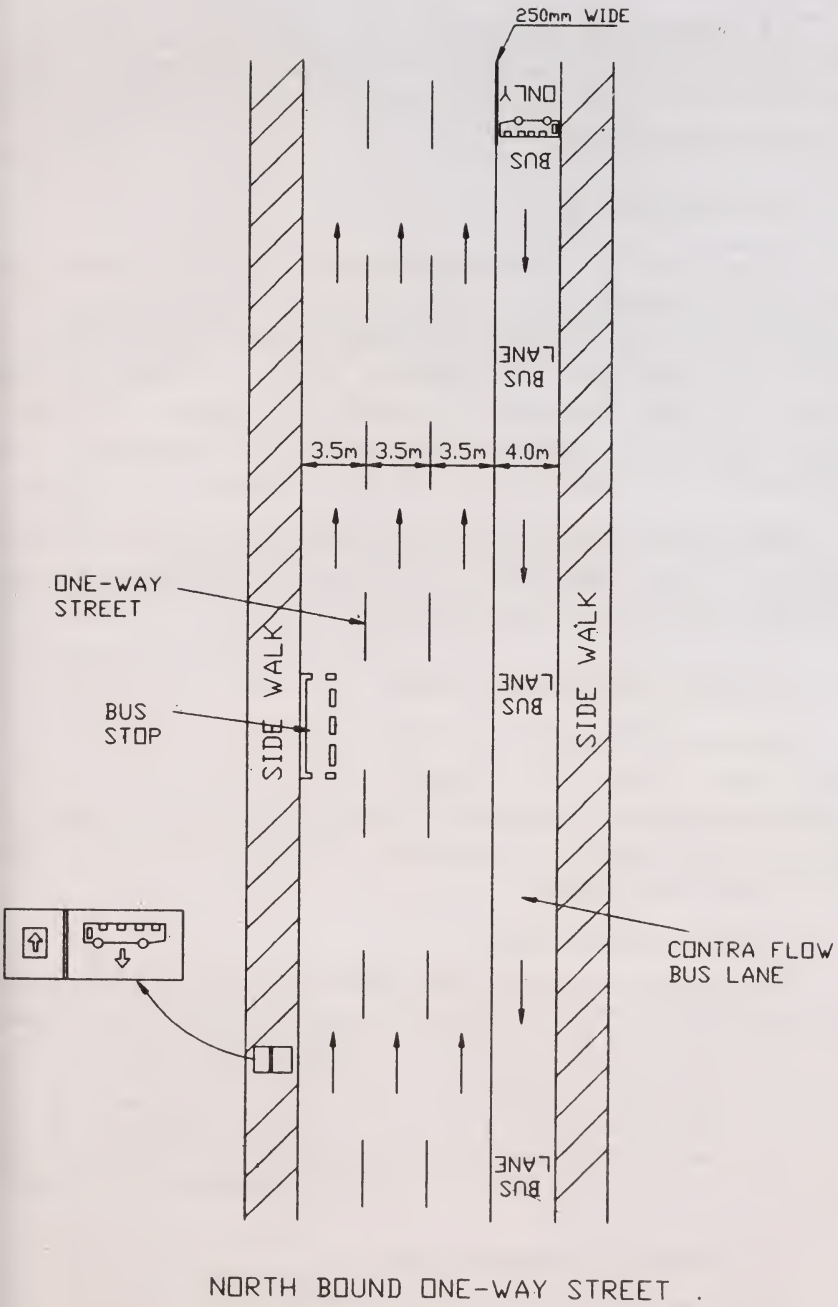


Fig. 12. Contra flow bus lane

8.2.3. **Reversible bus lane:** It is a with-flow bus lane that is provided in the centre and is used in the appropriate direction depending upon the direction of the peak-flow. During the non-peak period, this lane is used as a turning lane.

8.3. Bus Precincts

Bus precincts are 'bus only streets' also known as 'bus malls'. These are normally introduced in city centres where pedestrian and bus activity is very high. Access to such streets is permitted only to buses, emergency vehicles and pedestrians. The remaining traffic is normally diverted through other roads. Parking lots are created at the periphery, with access only through side lanes, so as to facilitate drivers to leave their cars in parking areas and take lift in buses (known as park-and-ride system).

The introduction requirements are mainly proper signage and lane markings. Central refuge islands should also be considered for helping pedestrians cross the carriageway safely.

8.4. Bus Priority Signal System

Traffic signals account for a major part of delay on urban streets. With a view to promoting the public transport system they may be accorded high priority by suitable modifications of the signals system so that there is minimum delay at intersections. This can be achieved through the following two methods:

(i) Bus pre-emption technique

'Bus pre-emption is achieved by fitting transponders on buses and receivers on traffic signal controllers. When a bus approaches a signal, the transponder sends a signal which is detected by the loop-detector in the carriageway. This detector, in turn, communicates with the signal controller which either terminates the cross-flow early or extends the running green on the approach to enable the bus to clear the intersection. To prevent traffic queues building up on side roads, an additional running time can be subsequently allocated to them when no bus is present on the main road, thus restoring some of the time lost to other traffic. Such priority can be extended to even emergency vehicles.

(ii) Co-ordinated traffic signals system

As buses have to halt at various stops between the signals and the halting time keeps varying, they can rarely take advantage of the co-ordinated signals systems. To overcome

this problem, a computer software has been developed to optimise the signal settings to minimise delay to buses throughout the control network. This programme takes into account the variation in bus journey time (compared with other vehicles) along each link and the time spent at bus stops on that link. Accordingly, the priority is accorded to buses.

In the signal system that is not vehicle-actuated, the fixed time signal can be so designed as to give extra preference to the link having the maximum bus routes. Another solution is to provide bus sluice (an empty lane from the end of bus lane to intersection stop line). The said empty lane is usable only by buses so that they can go ahead without getting caught in the traffic queue at the intersection. Naturally when the signal turns green buses would be the first to cross the intersection.

Though the bus priority signal system is not strictly low-cost, it is certainly cost-effective and can improve the overall efficiency of the public transit vehicles by 10 to 30 per cent.

8.5. Bus Operations Management System

The following bus operations management techniques can also be very useful in improving the public bus efficiency on important links. Such techniques help in reducing the waiting time at ticket counters and bus stops, time for getting in and out at loading/unloading points, besides minimising the chances on bunching of buses, especially during the peak hours, along major routes. This ultimately reduces delays at intersections and stagger the bus load uniformly in the entire network.

* bus stops resiting
* bus-routes modifications
* bus-schedule modifications
* shuttle bus services
* express bus services (limited stops)
* point to point service
* special buses for women
* park-and ride facilities
* simplified mode-transfers
* simplified fare-collection
* luxury bus services
* chartered bus services.

9. SELF-ENFORCING TECHNIQUES

Financial constraints and administrative difficulties restrain the use of manpower and modern equipment to the bare minimum. Therefore, it is necessary to evolve simple engineering and management techniques which can ensure traffic discipline automatically. The self-enforcing techniques make the enforcement easier and simpler, thus optimising the use of manpower and eliminating/minimising the need for modern/ specialised equipment. Some of these techniques are listed below:

9.1. Central Dividers

Central dividers on wide roads ensure that vehicles confine their movements only to the correct carriageway, thus avoiding any conflict with traffic from the opposite direction.

9.2. Railings

The railings over central dividers, or along footpaths, ensure that pedestrians do not cross erratically or spill over the carriageway.

9.3. Parabolic Dividers

Parabolic dividers and flower-beds which have a height of nearly 1 metre ensure pedestrian discipline. As the railings in the middle of roads are very vulnerable to accidents, parabolic dividers and flower-beds serve the same purpose more efficiently, besides improving the environment.

A typical parabolic divider is shown in Photograph 9 while Fig. 13 gives the specifications.

9.4. Channelisers

Channelisers at intersections ensure safe turning movement and proper lane discipline. Specially designed channelisers may be used at those corners where certain turning or movement restrictions are to be imposed. Some typical channelisers, commonly used, are shown in Fig. 14.

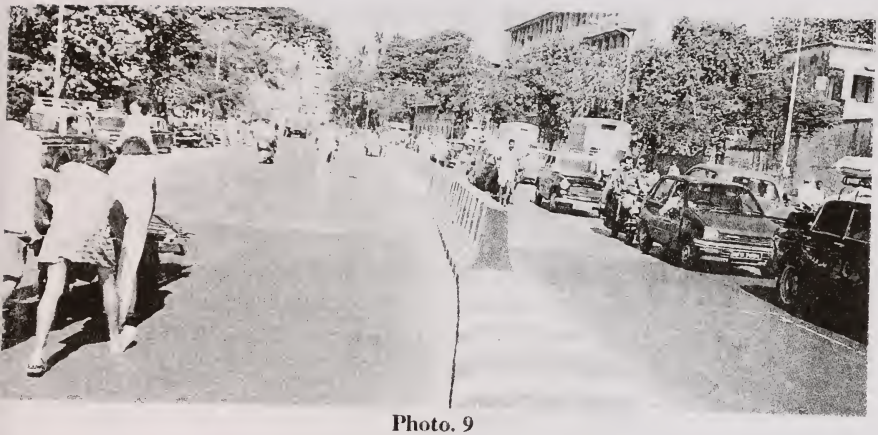


Photo. 9

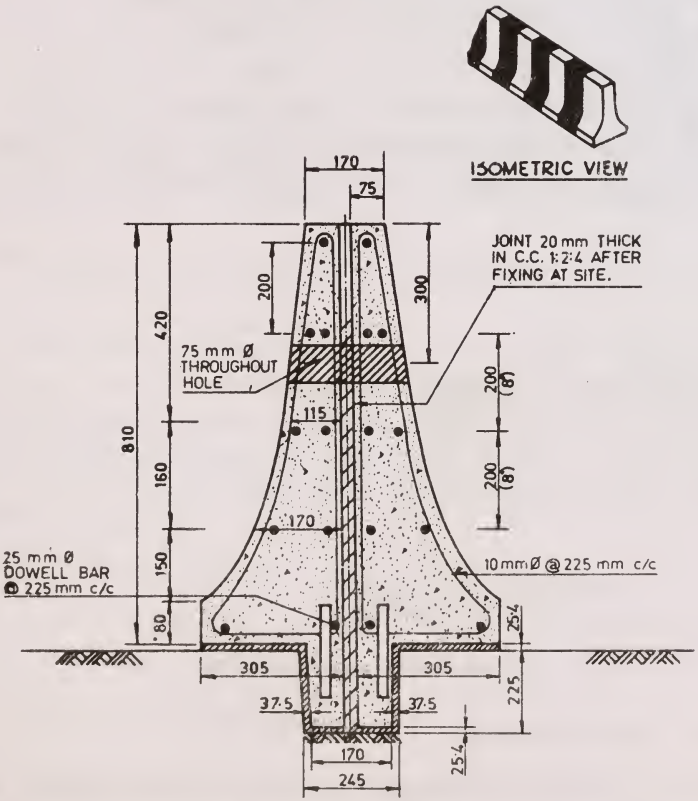


Fig. 13. Parabolic divider

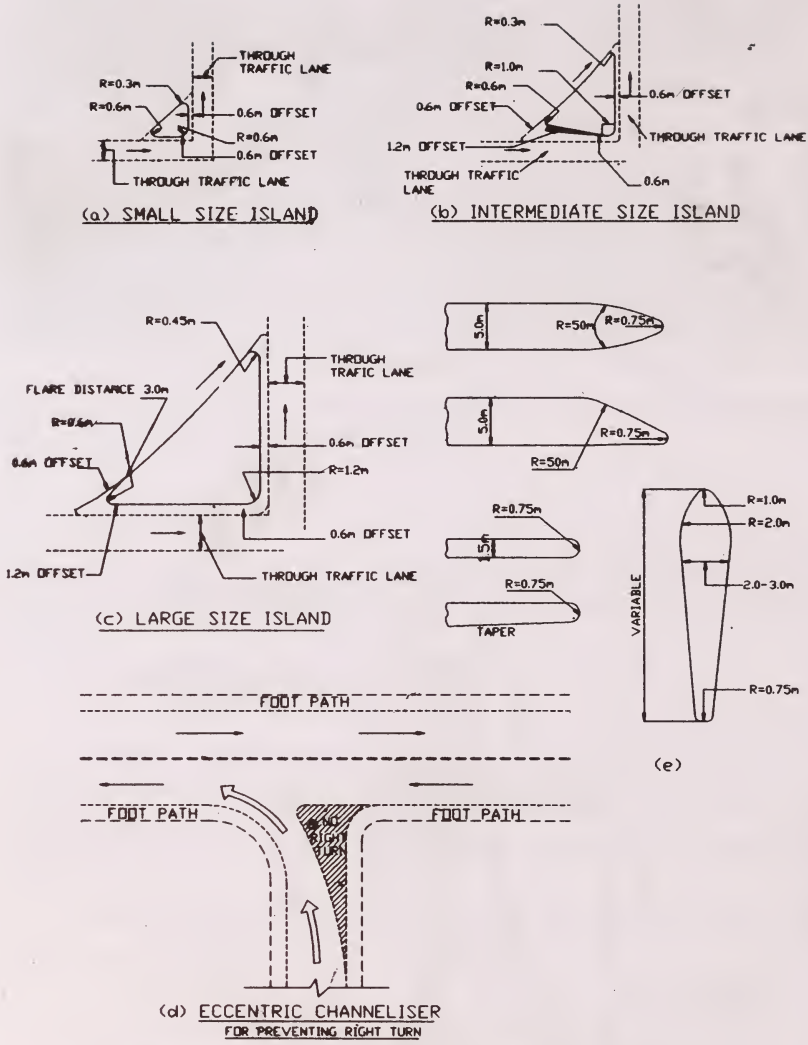


Fig. 14. Some typical channelisers

9.5. Queue Channels

To ensure taxi queue discipline at airports, railway stations, hotels, cinema theatres and other such important traffic generators, it is desirable

to delineate the queue channels by the use of raised kerbs so as to achieve the following:

* No unscrupulous taxi driver can jump queue to pick up passengers out of turn.
* The taxi queue does not interfere with the main traffic.
* The passengers are given a specific area for boarding & alighting so as to ensure their safety.
* Unless the first taxi moves, other taxi behind cannot. It would automatically ensure that no taxi refuses passengers for short distances.
* Only one police constable at the head of the queue can ensure proper discipline.

The width of such taxi channels should be about 2.2 metres for 4 wheelers and 2 metres for auto-rickshaws, Fig. 15.

9.6. **Parking Notches**

Wherever footpaths are very wide while the parking demand is very high, the authorities may consider permitting angular parking by providing notches in footpaths to ensure orderly parking and in-out movements, Fig. 16.

9.7. **Sleeping Policeman**

To avoid speed-breakers which are normally detested by most motorists, artificial bottlenecks can be created at such locations. Such bottlenecks also known as ''Sleeping Policeman'' (Fig. 17) can be in the form of convex protrusion of footpaths. These are provided generally in the residential areas where the traffic is mainly local. It serves the following functions:

* helps pedestrians as they have to cross shorter width;
* commands respect from drivers as they cannot afford to be fast;
* continuous parking nuisance is eliminated.

9.8. **Bus Bays/Bus Boxes**

Bus bays are useful for proper marshalling of buses to the bus stop without interferring with the main traffic flow on the carriageway. The

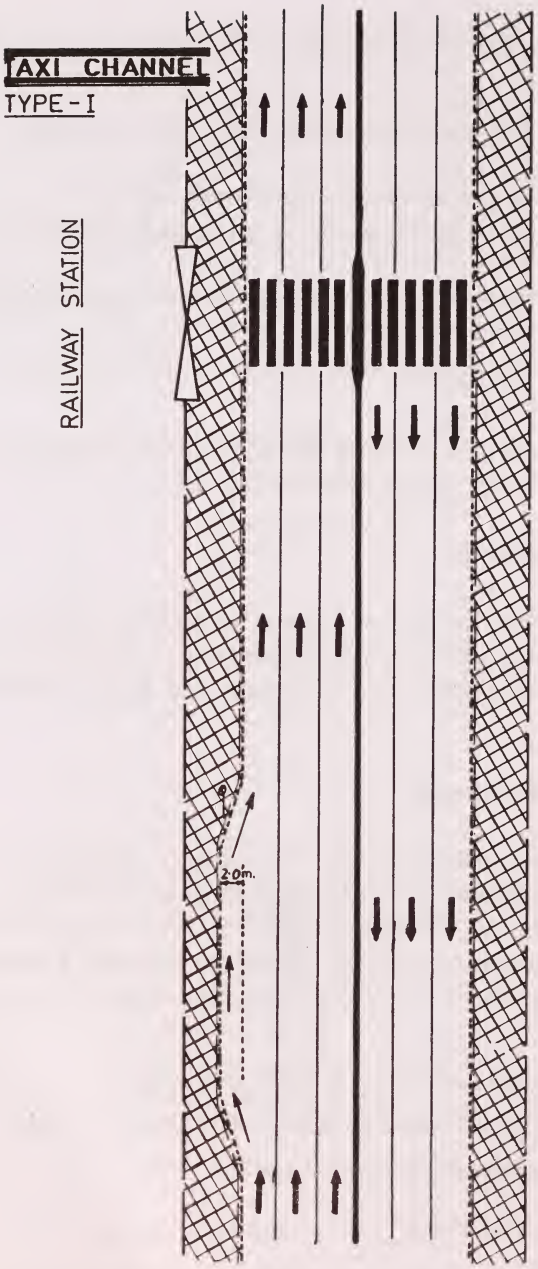


Fig. 15. Taxi channel

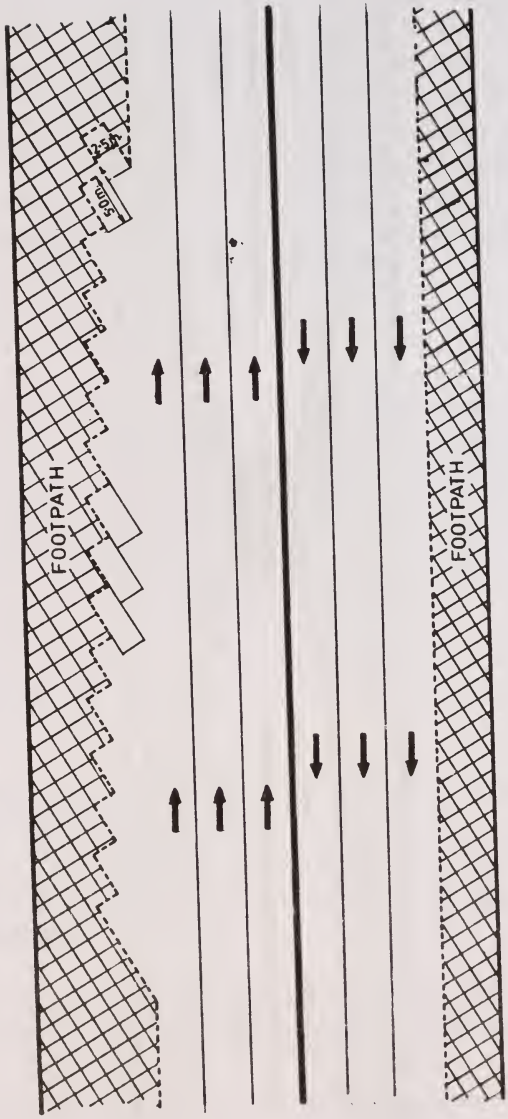


Fig. 16. Design notch for angular parking

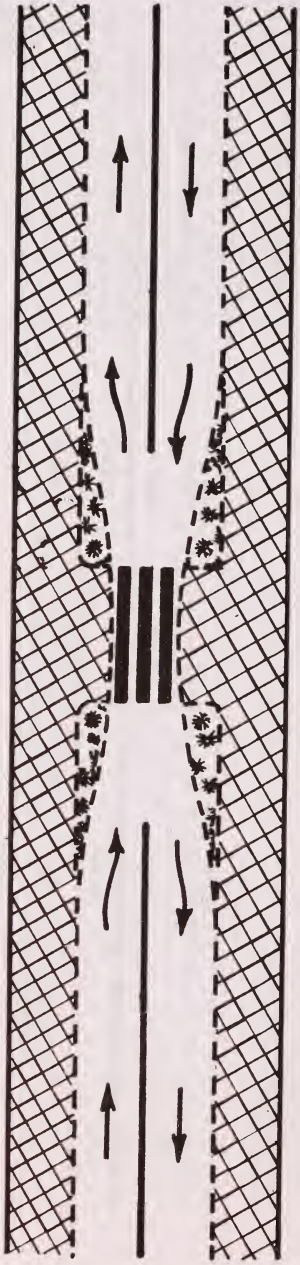


Fig. 17. Sleeping Policeman

width of such bus channels should not be less than 3 metres, delineated by a painted white strip. Where space permits, bus bays should be segregated by constructing raised dividers/islands. However, lighted bollards must be fixed at the mouth of such bays on the divider so as to fore-warn other motorists. The lay-byes (setbacks off the carriageway) are preferable. Where adequate space is not available for constructing a lay-bye, bus boxes should be painted in white for the guidance of drivers and commuters (Fig. 18). It will automatically ensure that commuters do not spill onto this channel area and confine themselves only to the bus stops. The lay-byes should conform to IRC:70-1977, "Guidelines on Regulation and Control of Mixed Traffic in Urban Areas".

9.9. **Share-a-Taxi System**

This system envisages a point-to-point service from an important traffic generator to a common destination. In this scheme a taxi carries four persons on a tariff computed on the basis of normal fare divided by three. In other words, while each passengers pays only one-third of the normal fare, the taxi driver gets about 33 per cent more. Naturally, the chances of refusal to ply over short distance or charging excessively, etc. are almost eliminated. Moreover, such taxis function as intermediate public transport, reducing the load on public buses and utilising the taxi occupancy to its optimum. Besides this system would increase the supply of public transport system.

The auto-rickshaws can also be covered by such scheme, carrying three passengers. Total fare, comprising normal fare increased by 25 per cent is divided by three to work out the tariff payable by each passenger. This system, in slightly different form, is operating in some of the cities like Surat, Jamshedpur, Indore, etc.

In large cities, this system can also benefit ladies who can form their own group for taking a common ride that makes them feel secured.

Such scheme should be worked out in close association with the taxi/auto-rickshaw associations after conducting survey of the areas so that there is enough clientage for a particular route. The waiting time should not exceed five minutes, which means four passengers must be available

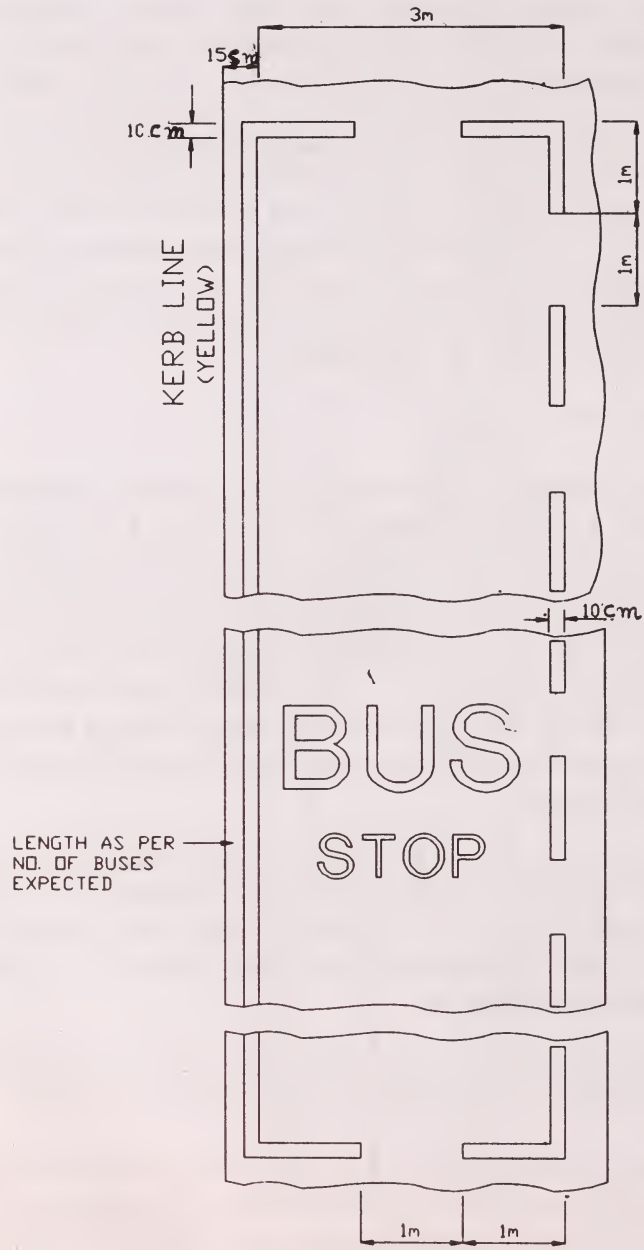


Fig. 18. Bus stop

every five minutes, so that the scheme along that route is successful. It is equally necessary to provide general taxi/auto-rickshaw stands in the close vicinity of share-a-taxi stand so that passengers have a choice.

9.10. **Fixed Tariff System (Pre-paid Service)**

At the airports, railway terminals, etc., there is a tendency on the part of taxi drivers to exploit passengers by overcharging or taking them through longer routes or refusing to ply over short distances, or fleeing passengers by other means. It naturally causes serious enforcement burden and the need for deployment of traffic police personnel check such activities. It is therefore, desirable to introduce the following system.

The entire city can be divided into various zones and the normal fares for the maximum distance in these zones are calculated. For the first zone, about 100 per cent extra incentive in the fare so calculated is given and the incentive for the subsequent zones is successively reduced; 30 per cent - 40 per cent being the incentive for the last zone. These incentives ensure that taxi-drivers are not tempted to indulge in mal-practices and do not refuse plying over a short distance after long waiting at the queue. The incentive amount offsets the waiting time.

A ticket counter is set up where the passenger buys a ticket for his destination zone at a fixed rate. His name, address and destination are recorded in the register and cab number is written on the receipt handed over to him. This receipt is countersigned by the passenger after reaching his destination. The taxi driver collects the fare from ticket counter by producing the countersigned receipt. The details of both the driver and passenger are available now with the traffic police. It ensures that, in the event of a problem or crime, the passengers/drivers can be immediately traced. It acts as a psychological deterrent to unscrupulous taxi drivers and provides a sense of security to the passengers. There is no monetary exchange between the driver and the passenger.

A token amount is charged as a part of the fare payable to the taxis as service charge. The amount so collected helps in the operation and maintenance of the ticket counters. Good sign-boards are absolutely necessary to inform passengers about this system. They should also

indicate various destinations and the chargeable fare. Warning boards should also be displayed advising passengers not to hire a taxi from any other place.

10. PUBLIC INTERACTION TECHNIQUES

Traffic Management scheme can hardly be successful without the active participation and acceptance of the public. Voluntary cooperation is essentially the first stage of public interaction, as it creates an environment where the road user is taken into confidence by the administration, to accept the right of other road users and willingly modify his own behaviour in the larger interests. Pedestrians crossing only at specified zebra crossing, motorists confining to their lanes, minimum use of horns, etc. are some illustrations of this dictum. This can be best achieved through public communication by using all possible media. The following media are generally available to the local administration.

10.1. Large Displays

These displays could be in the form of hoardings, banners, kiosks, some of the hoardings are as shown in Photographs 10, 11 and 12.

Photo. 10

Photo. 11

Photo. 12

Simple but interesting traffic messages can be conveyed through hoardings located at vantage points and banners near important intersections. These messages should be periodically changed to avoid monotony. All these displays should carry, as far as possible, the same message, or at least the same concept, during a certain period. It would ensure persistence of the same concept/message, and this would get impressed into road users mind since they would come across the same message throughout the city. Normally the periodicity of changing messages should be one month.

The bus shelters, foot overbridges and fly-overs can also be exploited for displaying such messages, as shown in Photographs 13 and 14.

Photo. 13

10.2. Electronic Hoardings

Electronic hoardings can be effectively used for relaying variable messages to keep the public not only informed of various traffic innovations but also to give them interesting facts and statistics so that their curiosity is maintained.

Photo. 14

10.3. **Mobile Messages**

Traffic messages can also be communicated by using stickers at the rear of taxis and cars; posters fixed at back and side panels as well as inside the public buses. These are shown in Photograph 15.

10.4. **Leaflets**

Leaflets providing advance information about modifications and implementation of new traffic schemes, special arrangements on the eve of important festivals and public functions, do's and don'ts of traffic safety; and other information of common public interest can be very effective. These should be printed in different languages namely: English, Hindi, and the local language (if different).

Photo. 15

10.5. **Periodical Press Notes**

The Press Note should be issued at regular intervals through leading newspapers and magazines informing the public about the proposed traffic management plans, enforcement drives, cautionary messages, accidents statistics and other useful traffic information that may be of interest to the public. All traffic regulations and changes must be made known to the public through such Press Notes.

Senior officers should also give interviews to the Press so that public gets an insight about the not-so-obvious traffic aspects. It also elicits public opinion about various measures taken by the local authorities so that the administration gets the correct feedback to enable it to reconsider certain changes and effect necessary alterations, if required.

10.6. **T.V. & Radio Broadcast**

T.V. and Radio are two very powerful media for reaching the public, T.V. interviews, panel discussions and road safety films. Radio broadcast on traffic related matters should be organised at frequent intervals in various languages. These two media can also be used for informing the public about various traffic management measures that become necessary on the eve of important events and major religious festivals.

In view of the development of cable T.V. network and video cassettes, the authorities can also persuade the concerned entrepreneurs to keep some slots for telecasting traffic messages. At the end of video cassette, normally blank recording space is available. It can be gainfully used for traffic messages/films.

10.7. **Greeting Cards**

Greeting Cards with suitable traffic message should be sent to important personalities, voluntary organisations, public representatives and political leaders, office bearers of various unions, members of the Press, eminent citizens and all those whose opinion matter in traffic management, on a couple of occasions such as New Year and other National days. These courtesies and decent gestures would earn the traffic authorities the appreciation and willing suppoprt of such persons, without which no major traffic management plan can be successful.

10.8. **Seminars and Talks**

Social organisations, commercial groups, associations representing interest of road users, etc. should be encouraged to hold seminars, symposia, workshops and panel discussions. All proposed important traffic management schemes that are likely to have major impact on the movement of various road users can be discussed threadbare so that the benefits that are likely to accrue get highlighted and apprehensions of the public, if any, are removed. It would also help in getting the objective feedback so that the authorities may consider various suggestions and effect appropriate modifications, if so required

10.9. **Committees**

Various committees representing interests of different road users should be formed so that all sections of road users feel that their interests are being safeguarded by their representatives. Regular meetings should also be held with the representatives of various unions of taximen, transport operators, auto-rickshaws, etc. Special consultative committees should be formed to deal with the specific issues, as it helps in bringing members, representing divergent interests, across the table

to appreciate various pros and cons of any important traffic management scheme.

10.10. Students Participation

The students should be actively involved in traffic discipline and road safety so that an era of traffic culture can be ushered in.

The authorities should encourage 'Road Safety Patrol' (R.S.P.) activities in all schools covering children of the age group of 9-14. Traffic officers should visit such schools and impart them traffic education. They should be shown traffic safety films and guided about various do's and don'ts on the road. Outdoor activities like Road Safety Weeks, Fuel Conservation Weeks, RSP Camps, etc. should be periodically organised, besides holding essay, painting, slogan and quiz contests on traffic subjects, so as to stimulate the young ones thinking on this vital aspect of life. The services of these children should also be used during important bandobasts to supplement the traffic manpower.

It is equally necessary to involve the college students in similar activities for promoting road safety. They can also help the traffic police in disciplining the pedestrians, other road users, and controlling the bus queues, etc.

10.11. Traffic Warden Scheme

It is equally necessary to seek community participation in traffic control and road sefety. Volunteers amongst the public should be intelligently selected so that the undesirable elements do not enter the ranks. Such volunteers should be imparted special training and then inducted as traffic wardens. They can help in controlling traffic at intersections, disciplining the pedestrians and noting down traffic violations. Periodical review meetings should be held with them. However, a close watch on their working is necessary to make sure that no one takes undue advantage of these powers.

10.12. Traffic Exhibitions

The authorities should prepare interesting audio-visual displays, electronics games, etc. to convey traffic messages more effectively. They

should hold exhibitions with these displays and screen road safety films at different places to educate the common man.

10.13. Traffic Parks

Children parks should be created to inject traffic awareness amongst school children through 'play & learn games'. Such parks teach the children as to how they should make use of the roads as motorists, cyclists as well as pedestrians. Photograph 16 show some profiles of such parks.

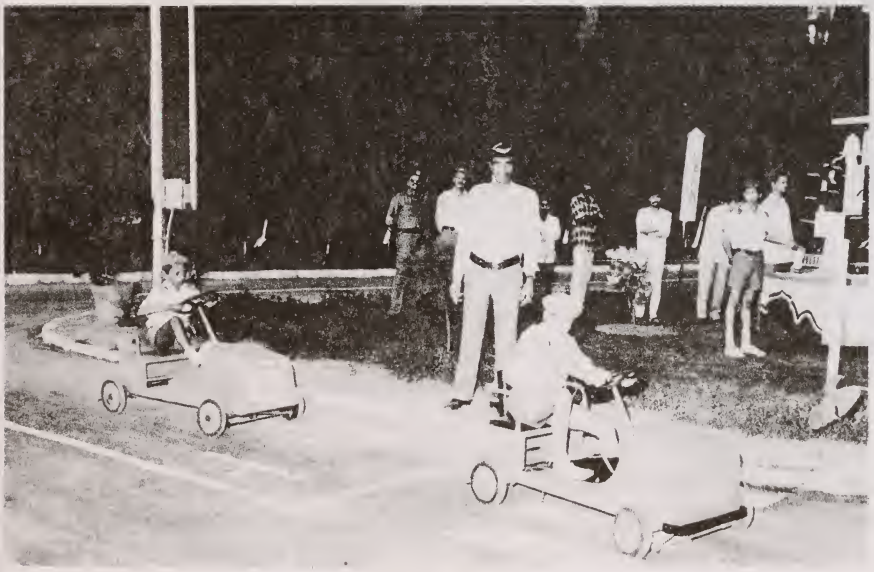


Photo. 16

10.14. Traffic Booths/Aid Post

Small cabins should be installed at important locations such as railway stations, airports, bus terminals and other important areas so that Traffic Police can provide general assistance to the public in terms of information, first-aid, communication, etc. These booths should display useful information about hospitals, airlines and train timings, hotels, etc. so as to enhance the image of the Traffic Department as good samaritans. They also provide a nucleus and field base for the traffic personnel deployed in a particular area. One such booth is shown in Photograph 17.

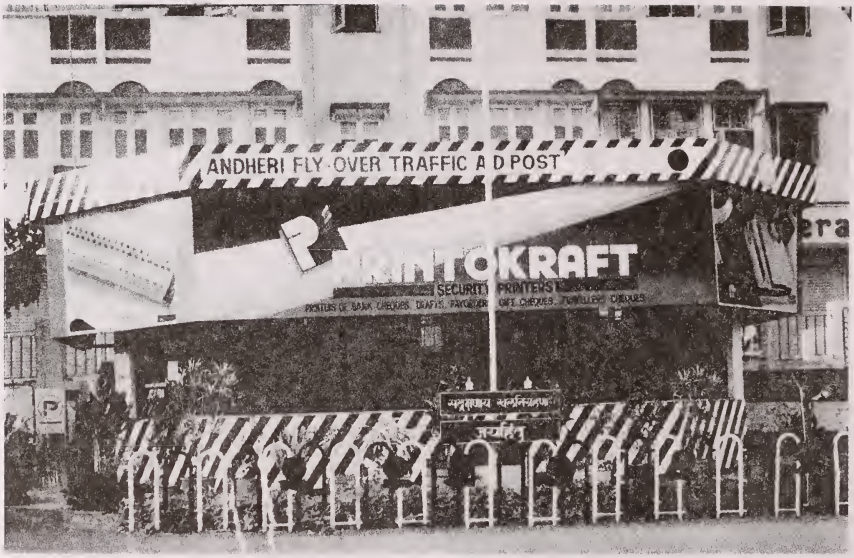


Photo. 17

These public relations/public interaction techniques can energise the community into active participation. Large business houses, social organisations and various citizens groups can be thus motivated to provide the infrastructure to impart traffic education and the above mentioned traffic aids. In return, they can be allowed to advertise their names and logos on all such aids. Their help can be sought for providing, in addition to the aforementioned items, footpath and central railings, road dividers, traffic cones, lighted bollards, information road signs, etc. They can also be involved in beautifying various traffic islands, central verges and roundabouts by turning them into beautiful gardens and green areas.

11. INSTITUTIONAL COORDINATION AND CITIZENS' COOPERATION

The traffic control and management basically involve three components viz. road, vehicle and road user. It is, therefore, the joint responsibility of all the organisations responsible for its operating environment. Unless all the concerned organisations interact with each other and coordinate their efforts, the traffic police and traffic engineers alone can not successfully meet the ever growing challenges thrown by the urban traffic and transportation problems.

11.1. Institutional Coordination

The following three major areas, in particular, require good coordination between various utilities.

11.1.1. **Roads:** The local Municipal Corporation/PWD must ensure good maintenance of all roads and footpaths including channelisers. All safety measures should conform to the I.R.C. standards and must be maintained well. Good street lighting system in urban areas can be very effective in reducing accidents. Concrete and mastic surface provide better riding quality and have longer life.

11.1.2. **Road-side frictions:** The road-side frictions specially activities on road side reduce the road capacity, for example the encr achment of footpaths forcing pedestrians to use main carriageways. The other examples are: dumping of construction material and garbage on roads/footpaths, poor location of manholes, erection of a large number of poles, other installations like junction boxes, traffic sign-boards, manhole chambers etc, huge hoardings and other protruding structures on road side. There are many other encroachments like street vendors, pavement dwellers, beggers and squatting of animals, etc. which not only constrict the vehicular movement as a esults of inevitable conflicts, but also impede the smooth and safe flow of pedestrians.

It is, therefore, essential and desirable to formulate certain policies and guidelines for regulating the aforementioned road-side frictions. Joint action by the local municipal bodies and police can help bring about better discipline.

A joint survey can also be arranged by the concerned departments to see how various poles on roads and footpaths can be put to multipurpose usage. For instance, no parking sign-boards can be fixed on electric/ telephone poles along footpath wherever possible. Such surveys can help reduce the street furniture and thus improve the movement on roads and footpaths.

11.1.3. **Excavations:** A large number of excavations are regularly undertaken by various utilities like the water, sewerage, road maintenance

department, telecommunication and electric supply departments, gas authority, etc. Unless these excavations are properly coordinated with respect to space and time, they can cause serious traffic disruptions. As such excavations are not normally taken during the monsoon, it would be desirable to plan any such excavations which have to be inevitably carried out during the monsoon time. The traffic police can coordinate and monitor so that minimum inconvenience is caused to the road users.

11.2. Enforcement

Beside the aforementioned three areas, good enforcement of rules and effective checking of violations by the traffic police can play an important role in improving the carrying capacity of the carriageway.

However, a very vital aspect of the enforcement is the manner in which individual officers and constables behave while enforcing traffic laws in general, and new traffic schemes in particular. The experience usually makes a long-lasting impression on the person concerned, and he describes it to his family, to his friends and business acquaintances. It is the aggregate of such impressions which largely makes public opinion. It is, therefore, very important to ensure that in enforcing the law, the goodwill of the public is not forfeited. Thus, it is very essential to impart good education to the officers and men in the field in ''Public Relations''.

While cooperation between the public and the police is of utmost value, it can only be based upon mutual respect and understanding as well as complete recognition and acceptance of both sides. There can be no proper cooperation on the part of the police.

11.3. Citizen's Participation

While effective resource-utilisation by judicious application of traffic management techniques, well researched low-cost modern technology to update the existing transportation facilities, and computer usage to forecast the transportation needs to work out various alternatives, may well be the present day traffic manager's panacea for maximising the level of service and satisfaction, the one variable that can throw even

the best traffic management plan into disarray is the lack of the citizen's confidence.

A change unilaterally imposed is most likely to be opposed. It is, therefore, unwise to initiate any new measures of traffic regulation and enforcement without adequate preparation to ensure some measure of public understanding and some degree of public acceptance.

In reality, public participation in traffic management falls woefully short. The reasons are not too far to seek. Urban society is no longer the homogeneous community as it was. A vast change in its basic structure has been brought about due to mass exodus from rural areas. The new immigrant is an alien in the urban environment. The pressures of daily life in his changed circumstances keep him totally involved with his personal problems. He has neither the energy nor any inclination to involve himself in community matters. The local resident, on the other hand, views every administrative change as an intrusion into his traditional life and is not kindly disposed towards any such changes. The administration thus is often caught between the unconcern of one section and the apprehension of the other, making the task of the traffic manager very arduous. With the public responding more positively, he can produce solutions from various alternatives that will generally be acceptable to both sections of the society and that are in consonance with the government policies.

The success of any traffic management scheme thus rests on the pivots of public participation and institutional coordination. The lowest-cost traffic management techniques, therefore aim to win the confidence of the road user and enhance the credibility of the administration through the coordinated efforts of various public agencies involved in the traffic and transportation management. Even if adequate funds are not available for the implementation of various schemes, these efforts will generate a lot of public goodwill and ensure their voluntary cooperation in making the authorities task easier.